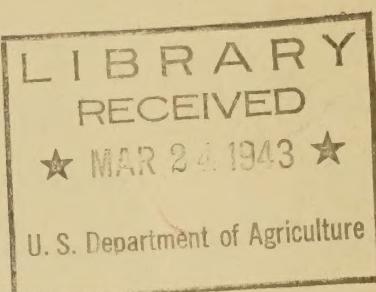


Dehydration Committee
U.S. Bureau of Agricultural Chemistry and Engineering, Dehydration committ
U. S. Department of Agriculture.

1932
A2Es8

✓
ESTIMATES OF EQUIPMENT COSTS AND LABOR REQUIREMENTS
IN
VEGETABLE DEHYDRATION.

Plant Capacity--400 Pounds Per Hour
(Unprepared Basis)



Note:

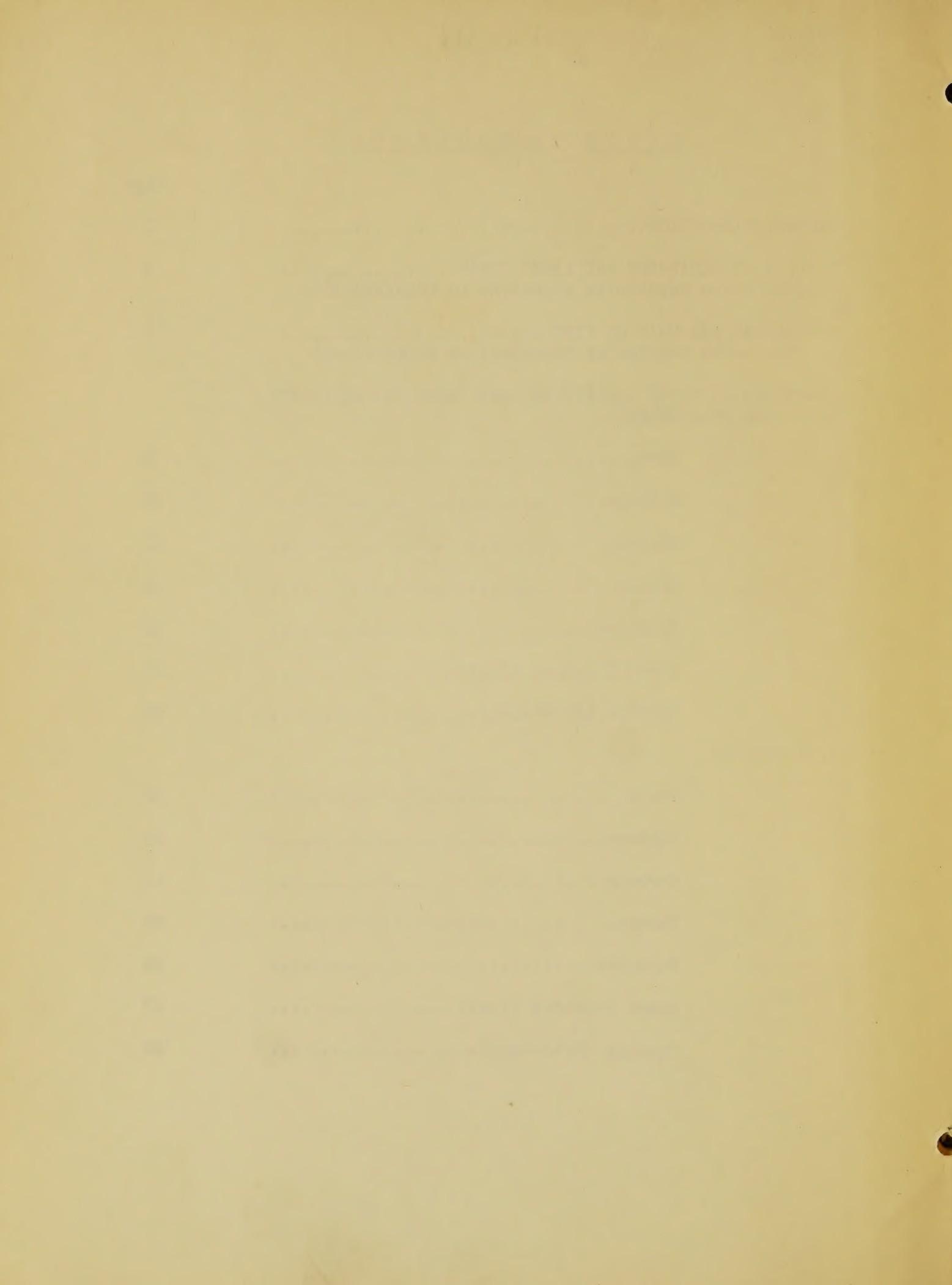
Preparation, final inspection and packaging equipment are the only types of equipment considered in this report. All labor requirements except clerical and shipping are included.

August 1942

2020
91.1

TABLE OF CONTENTS

| | Page |
|--|------|
| GENERAL DISCUSSION..... | 1 |
| SUMMARY OF EQUIPMENT AND LABOR COSTS..... (For seven vegetables important in dehydration) | 5 |
| CAPACITIES PER UNIT OF TIME..... (For seven vegetables important in dehydration) | 6 |
| PREPARATION, FINAL INSPECTION, AND PACKAGING EQUIPMENT, AND LABOR REQUIREMENTS: | |
| Beets..... | 8 |
| Cabbage..... | 10 |
| Carrots..... | 12 |
| Onions..... | 14 |
| Potatoes..... | 16 |
| Sweet Potatoes (Yams)..... | 18 |
| Turnips (Rutabagas)..... | 20 |
| FLOW SHEETS: | |
| Beets..... | 22 |
| Cabbage..... | 23 |
| Carrots..... | 24 |
| Onions..... | 25 |
| Potatoes..... | 26 |
| Sweet Potatoes (Yams)..... | 27 |
| Turnips (Rutabagas)..... | 28 |



Preparation, Final Inspection, and Packaging Equipment,
and Labor Requirements in
Vegetable Dehydration at a Plant Capacity of 400 Pounds per Hour,
Unprepared Basis

This discussion deals with preparation and packaging equipment costs and labor requirements in dehydration plants capable of handling 400 pounds per hour, unprepared basis. It is apparent that the tonnage handled is directly proportional to the length of the operating day, which in turn will depend upon the drying time and the number of batches dried per day. Plants this size will usually operate with batch (cabinet type) driers.

Since the operation in these small units cannot be continuous, it will be necessary to hold the vegetables somewhere along the preparation line in order to accumulate enough material to fill a car completely. The following table presents the maximum allowable holding times as given in the Tentative Federal Specifications:

| Vegetable | After Cutting | | |
|----------------------|----------------|------------------------------|-----------------|
| | Holding in air | Holding in Water or in Brine | After Blanching |
| Beets | : | : | : |
| Cabbage | : 15 minutes | : 1 hour | : 2 " |
| Carrots | : 30 " | : 1 " | : 2 " |
| Onions | : 2 hours | : | : |
| Potatoes | : 30 minutes | : 3 hours | : 3 hours |
| Sweet potatoes(Yams) | : 30 " | : 3 " | : 3 " |
| Turnips (Rutabagas) | : | : | : 2 " |
| | : | : | : |

It, therefore, appears that the only place to hold the vegetables to allow for most efficient operation is after blanching; in the case of onions, which are not blanched, holding after slicing is satisfactory. When all seven vegetables are considered, the allowable maximum holding time is 2 hours. In working out uniform operating details for plants, no more than two hours should be allowed in loading cars and getting them into the driers. Assuming that the total tray surface of each car will be around 400 square feet, with preparation losses and loading per square foot as mentioned below, the hourly capacity with which this discussion deals will not require a waiting period of over 2 hours on any of these seven vegetables.

The lists of equipment given herein and indicated methods of operation are intended to be merely suggestive. Other items of

equipment as well as other operating procedures may be equally satisfactory or even better. For instance, mechanical abrasive peelers have been assumed. Lye peeling, if permitted by the purchase specifications, may be preferable on carrots, potatoes, and other hard root vegetables. Other peeling methods, for example, carbonization by flame or radiant heat, followed by vigorous scrubbing, have also shown promise on an experimental basis. Carrots, turnips, and beets are shown as being peeled before topping. Under certain conditions it may be advisable to do the topping before peeling and the trimming after peeling. Standard abrasive peelers have not proven entirely satisfactory on onions. Operators have adopted various expedients to overcome this difficulty.

Costs and descriptions of equipment are based upon prices and information from established manufacturers in this field. The labor set-ups shown are based upon cannery operations and the operations of present commercial dehydrators. It is, of course, not possible to utilize labor efficiently in such a small scale plant as is herein considered, and allowance has been made for this fact. If the items of equipment or sequence and methods of operations are different from those given here, the labor set-up must be modified accordingly.

Items of equipment have been listed in greater detail for this size plant because the cost of small items is a relatively greater proportion of the total equipment cost. The operator will have to improvise equipment even more for a plant this size than has been suggested for the larger size plants. Satisfactory small equipment is difficult to obtain, the small units usually lacking the ruggedness necessary for continuous operation. Unless the operator can devise some substitute, he will have to purchase cannery size equipment. For instance, the smallest satisfactory motor driven slicer we have listed sells for \$475. If some inexpensive and sufficiently sturdy device could be made that would allow the women, upon completion of trimming, to slice each vegetable with a simple push of a lever by hand or foot, this would eliminate one handling step and at the same time reduce the amount of money needed to purchase the slicing equipment. A small hand-operated machine is available for stripping potatoes; its cost is \$25.

Only one form of prepared vegetable has been considered. Preparation of the vegetables in other forms will necessitate the installation of other types of cutters and will usually entail an increase in cost. However, if all vegetables were to be strip-cut, a saving in equipment cost might be accomplished. The labor set-up may also be affected to some extent by resulting differences in blancher loading, tray loading, and drying time.

A water spray at the beginning of the blancher belt is quite satisfactory in washing the diced, sliced, or stripped vegetables.

A separate washer to do the same work may cost several hundred dollars. If the washing is manual, the services of another employee may be required. Such a water spray at the front end of the blancher belt tends to prevent excessive humidity in the preparation room by condensing steam escaping from this end of the blancher. The amount of steam necessary for blanching will vary from plant to plant depending upon losses from the blancher and care in the avoidance of steam wastage. The range may be from 1 to 3 boiler horsepower for each ton of unprepared vegetables handled per 24-hour period. Except for beets and sweet potatoes, a requirement of 2 boiler horsepower per ton per day has been assumed. Due to retort blanching used for beets, a slightly larger amount is considered necessary. Sweet potatoes are scalded as well as blanched. Due to this double heating, they require somewhat more steam capacity. The plant operator can lessen the investment in steam boilers by insuring proper plant operation to minimize the steam losses and by operating the steam boiler above its rated capacity.

The standard drying tray is 3' x 6'. This size requires two men to lift it onto the car. It is probably better in a small plant to use 3' x 3' trays, which require only one man to handle them. This is an important factor where labor is used somewhat inefficiently due to the necessity of having an employee perform only one or two operations regardless of the throughput at any particular point.

The balance between labor and machinery is a factor that is very important. The initial cost of a labor-saving machine may be large, but the labor cost saved may be much larger than the annual charge on the machine, even in a plant as small as the one considered here. Raised platforms and discharge chutes will greatly assist in reducing handling costs.

The cost of packaging equipment is based on the assumed use of 5-gallon cans. Recent practice has been to solder the top after filling the can with inert gas. A regulator valve for the gas, relatively inexpensive soldering equipment, and scales are the main items needed for this type of packaging. Other types of packaging might involve a larger capital investment. Automatic can sealers have been recently introduced. These use a plastic sealing material under the edge of the lid which eliminates the necessity for soldering. No increased capital investment is ordinarily involved in the use of the automatic can sealer since the machines are leased to the user. In a small plant such as the one considered here, it is questionable if the use of such a can sealer could be economically justified on the basis of cost alone.

No provision for waste disposal equipment has been made in these estimated costs. Since disposal of waste is a very important and sometimes costly factor, it cannot be overlooked in setting up a plant.

Due to the many factors involved, no attempt is being made at this time to show the cost of such equipment. Economical disposal of preparation wastes will usually require some ingenuity on the part of plant operators.

An allowance of 40% has been made for installation and accessory equipment. Since most of the conveying and elevating will be done manually, no additional allowance has been made for improvised items. Equipment has been listed in greater detail for this size plant than for the larger ones because small items are relatively more important.

It is assumed that the extra men shown on the accompanying charts will assist in actual processing of the material, in care and operation of the equipment, and in removal of wastes from the plant. It has not been indicated on the flowsheets if a man does more than one operation. Each man's work is, however, described on separate sheets which itemize equipment and labor requirements.

Since actual working time in an 8-hour shift may be only 7 hours, the indicated hourly capacities are only intended to be an average of the quantities handled during an 8-hour shift. Quantities handled in any one hour of actual operation will have to be slightly higher if the assumed rate of production is to be maintained throughout a complete shift. The number of employees indicated should as a rule be sufficient to cover this difference.

Daily input, based upon 400 pounds of unprepared product per hour, is as follows for different lengths of operating day on the preparation line:

| 4 hour preparation day | -- | 0.8 tons |
|------------------------|----|----------|
| 8 " | " | 1.6 " |
| 12 " | " | 2.4 " |
| 16 " | " | 3.2 " |
| 24 " | " | 4.8 " |

SUMMARY OF COSTS

Preparation, Final Inspection, and Packaging Equipment,
and Labor Requirements in
Vegetable Dehydration at a Plant Capacity of 400 Pounds per Hour

Unprepared Basis

| Name of Vegetable | Shrinkage Ratio | Total | Equipment Cost | | Labor Cost | |
|-------------------|--------------------|--------|--------------------------|-------|--------------------------|------|
| | | | Per Ton | \$/ | Per Pound | \$/ |
| | | | Wet (Unpre- pared) | Dry | Wet (Unpre- pared) | Dry |
| Table beets | 13 to 1 | 2,000 | 417. | 5417. | 1.98 | 25.5 |
| Cabbage | 19 to 1 | 2,095 | 436. | 8293. | 1.49 | 28.3 |
| Carrots | 10 to 1 | 2,665. | 556. | 5552. | 1.79 | 17.0 |
| Onions | 14 to 1 | 1,240. | 258. | 3617. | 1.45 | 20.5 |
| Potatoes | 7 to 1 | 2,245. | 468. | 3276. | 2.09 | 14.7 |
| Sweet Potatoes | 4½ to 1 | 3,015. | 628. | 3827. | 1.79 | 8.0 |
| Turnips | 10 to 1 | 2,665. | 556. | 5552. | 1.79 | 17.9 |

1/ Equipment cost per ton handled per 24-hour day.

Capacities per Unit of Time
in a Vegetable Dehydration Plant
Capable of Handling 400 Pounds per Hour

(Unprepared Basis)

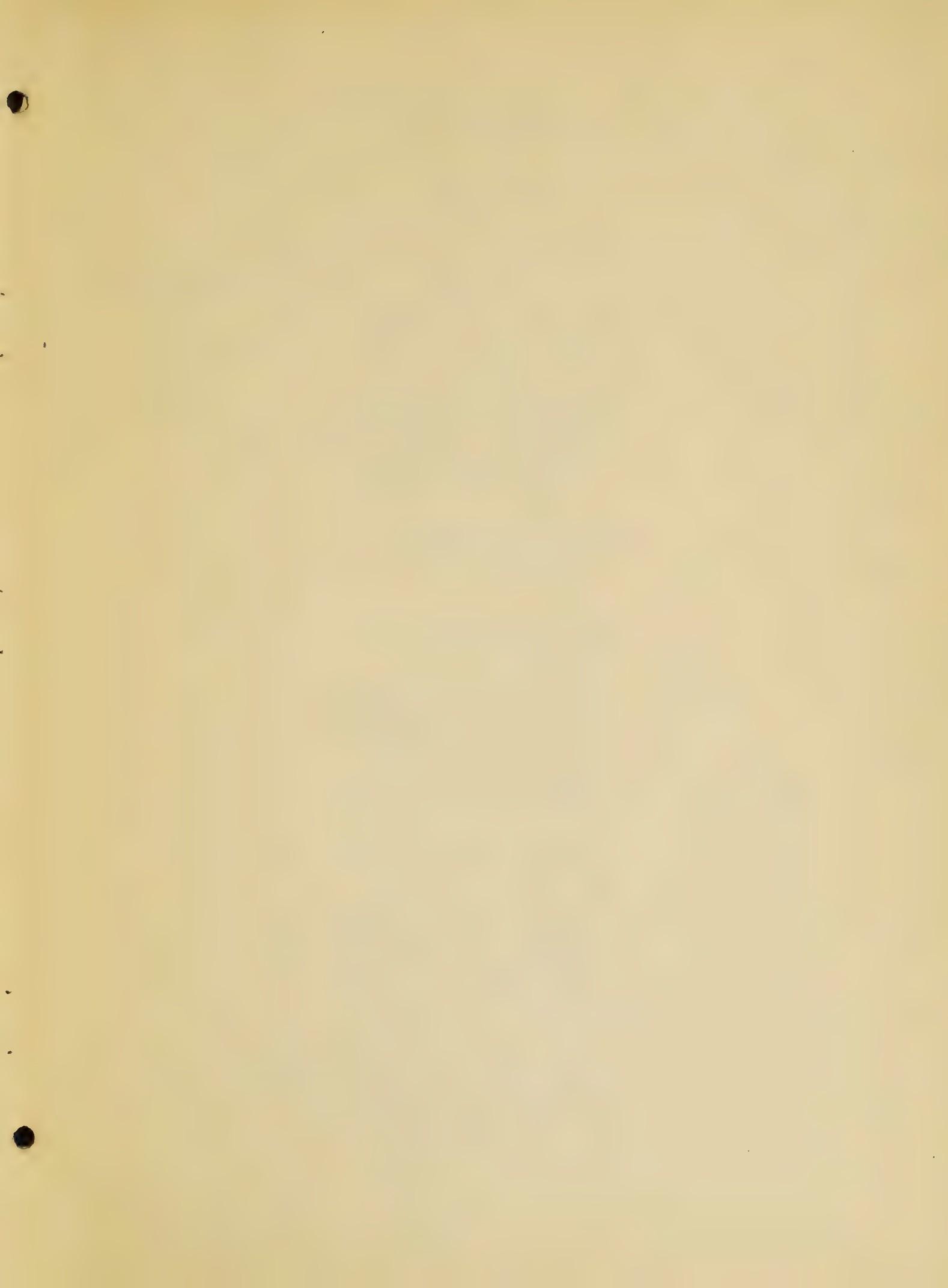
| Form Prepared | Beets | Cabbage | Carrots | Onions | Potatoes | Sweet Potatoes (Yams) | Turnips |
|---|--------|---------|---------|--------|----------|-----------------------|---------|
| | Slices | Shreds | Slices | Slices | Strips | Slices | Slices |
| <u>Unprepared basis:</u> | | | | | | | |
| Tons per 24-hour day | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Pounds " " " " | 9,600 | 9,600 | 9,600 | 9,600 | 9,600 | 9,600 | 9,600 |
| Pounds per hour | 400 | 400 | 400 | 400 | 400 | 400 | 400 |
| " " minute | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 | 6.7 |
| No. of women coring | | 1 | | | | | |
| Pounds per woman per hr. | | 400 | | | | | |
| " " " " min. | | 6.7 | | | | | |
| No. of retorts | 2 | | | | | | |
| Blanching time in minutes | 10 | | | | | | |
| Minutes per charge per retort - | | | | | | | |
| Loading, blanching & unloading | 20 | | | | | | |
| Charges per hour | 6 | | | | | | |
| Pounds per charge | 69 | | | | | | |
| Cars or crates per charge | 2 | | | | | | |
| Pounds per car or crate | 35 | | | | | | |
| <u>Prepared basis:</u> | | | | | | | |
| Assumed preparation loss | 30% | 25% | 25% | 15% | 25% | 25% | 20% |
| Tons per 24-hour day | 3.4 | 3.6 | 3.6 | 4.1 | 3.6 | 3.6 | 3.8 |
| Pounds per 24-hour day | 6,720 | 7,200 | 7,200 | 8,160 | 7,200 | 7,200 | 7,680 |
| Pounds per hour | 280 | 300 | 300 | 340 | 300 | 300 | 320 |
| Pounds per minute | 4.7 | 5.0 | 5.0 | 5.7 | 5.0 | 5.0 | 5.3 |
| No. of women sorting, tipping & trimming | 3 | | 3 | 2 | 5 | 3 | 3 |
| Pounds per woman per hour | 95 | | 100 | 170 | 60 | 100 | 105 |
| Pounds per woman per minute | 1.6 | | 1.7 | 2.8 | 1.0 | 1.7 | 1.8 |
| <u>Assumed blancher loading -</u> | | | | | | | |
| lbs. per square foot | | 1.5 | 2.0 | | 2.0 | 2.0 | 2.0 |
| Assumed blanching time in minutes | | 3 | 4 | | 4 | 6 | 4 |
| Pounds in blancher at any one time | | 15 | 20 | | 20 | 30 | 21 |
| Square feet of blancher needed | | 10 | 10 | | 10 | 15 | 10.5 |
| <u>Assumed tray loading -</u> | | | | | | | |
| lbs. per square foot | 1.5 | 1.2 | 1.5 | 1.2 | 1.5 | 1.5 | 1.5 |
| Pounds per car | 590 | 475 | 590 | 475 | 590 | 590 | 590 |

Capacities per Unit of Men
In a Vegetable Dehydration Plant
Capable of Handling 400 Pounds per Hour (cont'd)

| | (Unprepared basis) | | | | Bacon | Potatoes | Broccoli |
|-----------------------------|--------------------|---------|---------|--------|-----------------|----------|----------|
| | Beets | Cabbage | Carrots | Onions | Potatoes (Yams) | | |
| | Slices | Shreds | Slices | Slices | Strips | Slices | Slices |
| Units per 24-hour day | 10 | 15 | 12 | 17 | 12 | 12 | 10 |
| Units per hour | 0.42 | 0.63 | 0.51 | 0.72 | 0.51 | 0.51 | 0.56 |
| Yardage per car | 130 | 95 | 120 | 85 | 120 | 110 | 110 |
| Trays per car | 14 | 44 | 44 | 44 | 46 | 44 | 44 |
| Yards per tray | 13.5 | 10.8 | 13.5 | 10.8 | 13.5 | 13.5 | 13.5 |
| Units per 24-hour day | 500 | 700 | 530 | 750 | 530 | 530 | 570 |
| Units per hour | 21 | 28 | 22 | 31 | 22 | 22 | 21 |
| Yards per minute | 0.35 | 0.47 | 0.37 | 0.52 | 0.37 | 0.37 | 0.43 |
| Yards per tray | 170 | 130 | 160 | 115 | 160 | 160 | 150 |
| <i>Yield factors:</i> | | | | | | | |
| from overall shrinkage | | | | | | | |
| Yards | 19 to 1 | 10 to 1 | 14 to 1 | 7 to 1 | 4½ to 1 | | |
| Yards per 24-hour day | 10 | 960 | 570 | 1,370 | 2,130 | | |
| Yards per hour | 21 | 40 | 29 | 57 | 89 | | |
| Yards per minute | 0.35 | 0.67 | 0.48 | 0.95 | 1.5 | | |
| Canned per 5 gallon can | | | | | | | |
| Yards per 24-hour day | 5 | 14 | 9 | 16 | 1 | | |
| Yards per hour | 100 | 70 | 76 | 140 | 165 | | |
| Yards per car | 4.2 | 2.9 | 3.2 | 5.7 | 6.8 | | |
| | 14 | 21 | 19 | 11 | 8.8 | | |

(1)

(2)



Innkeeper Basic

| Operation | Employees | Work Done | Equipment Necessary | |
|--|------------|---|--|---------------|
| | | | Description | Approx. Cost |
| Scraping Trays, Packaging and Preparing for Shipping | 1 F 1 M | :2 people inspect and scrape trays, then package and crate product. Together, they can unload a car in about 30 minutes, or about 1/4 the time required to load a car. The remainder of time, until next car comes out of drier, can be spent in packaging. | Table and bin Scales, table and sealing equipment | \$ 50. 40. |
| General | 1 M 1 M | :Foreman :Helper, clean-up, washing trays, and maintenance. | | |
| | | | Sub-total | \$1,430. |
| | | :Add 40% for installation and accessory equipment | | 570. |
| | | | Total | \$2,000. |
| Labor Cost | | :Equipment cost per ton handled per 24-hr. day (unprepared basis). :Total Labor Requirements: : :4 Women @ 60¢ per hour :6 Men @ 75¢ per hour :1 Foreman | Total Labor Cost Per Hour: | \$ 417. |
| | | | | \$ 7.25 |
| | | :Labor cost per wet pound (400 pounds) :Labor cost per dry pound (31 pounds) | | 25.2 |
| Steam Generating | | :About 12½ boiler horsepower required for blanching :Cost estimated on basis of rated horsepower | BPTPA Cost | \$1,400. |

(continued)

Title: Estimation of Power Requirements and
Labor Requirements
(in a Dehydrating Plant Capable of Handling 400 Pounds per Hour)

Unprepared Basis

| Operation | Employees | Work Done | Equipment Necessary | |
|---------------------------|-----------|---|--|------------------|
| | | | Description | Approximate Cost |
| Trucking to Coring Table | 1 M | Man trucks cabbage from receiving platform to trimming and coring table. He also assists where needed. | Hand truck | \$ 15 |
| Trimming and Coring | 1 F | Coring can be done on an improvised corer located over a table | Improvised cabbage corer with 1/4 h.p. motor | \$ 10 |
| | | This washing can be accomplished by putting cabbage into water vats after coring. Any further washing if necessary can be done by hand. | Vat | \$ 10 |
| Washing | 1 M | Cabbage is removed from water vats and placed in shredder. Employee doing this also spreads cabbage on blancher belt. | Kraut cutter 21" disc with 1/2 h.p. motor | \$ 10 |
| Blanching | | 3 minute blanch. Loading on belt, 1 1/2 pounds per square foot. | Wire belt blancher, over all length, 10' Covered area, 12" x 10" with 1/2 h.p. motor | \$ 1,000 |
| Tray loading and Stacking | 1 M | Shreds are spread on trays and trays are stacked on cars. Operation takes about 2 minutes. Man doing this also loads drier. | Tray table 3" x 3" trays should be used. | \$ 100 |
| Drying | | Foreman regulates drier. | | |

| Operations | Employees | Work Done | Description | Approx. Cost |
|--|------------|---|---|---------------|
| Scraping Trays, Packaging and Preparing for Shipping | 1 F 1 M | : 2 people can inspect and scrape trays, then package and crate product. Together they can unload a car in about 30 minutes, or about 1/3 the time required to load a car. The remainder of time, until the next car comes out of drier, can be spent in packaging. | : Table and bin Scales, table and sealing equipment | \$ 50. 40. |
| General | 1 M 1 M | : Foreman Helper, cleanup, washing trays, and maintenance. | | |
| | | | : Sub-total | \$1,405 |
| | | : Add 40% for installation and accessory equipment. | | \$ 600 |
| | | | : Total | \$2,005 |
| | | : Equipment cost per ton handled per 24-hr. day (unprepared basis). | | \$ 436 |
| Labor Cost | | : Total Labor Requirements: 2 Women @ 60¢ per hour 5 Men @ 75¢ per hour 1 Foreman | : Total Labor Cost, Per Hour: \$1.20 3.75 1.00 | |
| | | : Labor cost per wet pound (400 pounds) | | |
| | | : Labor cost per dry pound (.21 pounds) | | .28 .3 |
| Generating: | | : About 10 boiler horsepower required for blanching Cost estimated on basis of rated horsepower | : Approx. Cost | \$1,030 |

Labor Requirements
In a Dehydratation Plant Capable of Handling 100 Pounds per Hour
Unprepared Basis

| Operation | Processes | Work Done | Equipment Required |
|---------------------------|-----------|--|---|
| Trucking and Washing | 1 M | Man trucks carrots from receiving platform, washes them on a screen, and places them in peeling machine. | Hand truck Washing equipment |
| Peeling | | Carrots are conveyed from peeler to trimming table on a chute. | Batch peeler with $\frac{1}{2}$ h.p. motor |
| Topping and Trimming | 3 F | Topping and trimming done on a table. | Table 3' x 6' |
| Slicing | 1 M | Carrots are taken from table and fed to slicing machine. Employee doing this also spreads slices on blancher belt. | Slicer with $\frac{1}{2}$ h.p. motor |
| Washing | | Sprays on front end of blancher. Included in blancher cost. | |
| Blanching | | 4 minute blanch. Loading on belt, 2 pounds per square foot. | Wire belt blancher, over all length, 17' x 12" x 10", with $\frac{1}{2}$ h.p. motor |
| Tray Loading and Stacking | 1 M | Slices are spread on trays and trays are stacked on cars. Operation takes about $2\frac{1}{2}$ minutes. Man doing this also loads drier. | Tray table 3" x 3" trays should be used |
| Drying | | Foreman regulates drier. | |

COSTS (continued)

| Operation | Empl- oyees | Work Done | Equipment Necessary | |
|--|----------------|--|--|-----------------|
| | | | Description | Approx. Cost |
| Scraping Trays, Packaging and Preparing for Shipping | 1 F 1 M | 2 people inspect and scrape trays, then package and crate product. Together, they can unload a car in about 30 minutes, or about 1/4 the time required to load a car. The remainder of time, until next car comes out of drier, can be spent in packaging. | Table and bin Scales, table and sealing equipment | \$ 50 40. |
| General | 1 M 1 M | Foreman Helper, cleanup, tray washing and maintenance | Sub-total | \$1,905. |
| | | Add 40% for installation and accessory equipment. | | 760 |
| | | | Total | \$2,665. |
| | | Equipment cost per ton handled per 24-hr. day (unprepared basis). | | |
| Labor Cost | | Labor Requirements: 4 Women @ 60¢ per hour 5 Men @ 75¢ per hour 1 Foreman | Total Labor Cost Per Hour: \$2.40 3.75 1.02 | |
| | | Labor cost per wet pound (400 pounds) | | 1.79 |
| | | Labor cost per dry pound (40 pounds) | | 12.7 |
| Steam Generating | | About 10 boiler horsepower required for blanching Cost estimated on basis of rated horsepower | Approx. | \$1,200. |

ONIONS

Preparation, Final Inspection and Packaging Equipment, and

Labor Requirements

In a Dried Onion Plant Capable of Handling 100 Pounds per Hour

Unprepared Basis

| Operation | Empl- oyees | Work Done | Equipment Necessary | | |
|--|----------------|---|--|-----------------|--|
| | | | Description | Approx. Cost | |
| Trucking and Peeling | 1 M | Onions are trucked from re- ceiving platform to peeler. After peeling, onions are then conveyed to sorting and trimming table on a chute. | Hand truck Batch peeler with $\frac{1}{2}$ h.p. motor | \$ 15. 225. | |
| Sorting and Trimming | 2 F | Sorting and trimming is done on a table After trimming, onions are placed in water. | Table 3' x 5' | 40. | |
| Fushing | | | Vat | 25. | |
| Slicing | | Man who puts onions into peeler takes them out of water and feeds them to slicing machine. | Slicer with $\frac{1}{2}$ h.p. motor | 475. | |
| Tray Loading and Stacking | 1 M | Slices are spread on trays and trays stacked on cars. Operation takes about 2 minutes. Man do- ing this also loads drier. | Tray table 3' x 3' trays should be used | 15. | |
| Drying | | Foreman regulates drier. | | | |
| Scraping Trays, Packaging and Preparing for Shipping | 1 F | 2 people can inspect and scrape trays, then package and crate product. | Table and bin | 50. | |
| | 1 M | Together they can unload a car in about 30 minutes, or about 1/3 the time re- quired to load a car. The remainder of time, until the next car comes out of drier, can be spent in packaging. | Scales, table and sealing equipment | 40. | |

1. *Chlorophytum* (L.) Willd.

2. *Chlorophytum* (L.) Willd.

3. *Chlorophytum* (L.) Willd.

4. *Chlorophytum* (L.) Willd.

5. *Chlorophytum* (L.) Willd.

6. *Chlorophytum* (L.) Willd.

DEHYDRATION
Preparation, Firing, Trimming and Processing Equipment, and
Labor Requirements
In a Dehydration Plant Capable of Handling 700 Pounds per hour

Unprepared Basis

| Operation | Empl- oyees | Work Done | Equipment Required | |
|---------------------------------------|----------------|---|--|----------------------|
| | | | Description | Cost |
| Trucking and washing | 1 M | Potatoes are trucked from receiving platform and washed on a screen. | Hand truck Washing equipment | \$ 10.00 \$ 35.00 |
| Dicing | | It would be advisable to buy pre-graded potatoes. | | |
| Peeling | | Man who washes potatoes also puts them in peeling machine. Potatoes are conveyed from peeler to trimming table on a chute. | Batch peeler with $\frac{1}{2}$ h.p. motor | \$ 25.00 |
| Sorting, trimming and stripping | 5 F | Sorting and trimming is done on a table. Each woman has a hand operated strip cutter. Each trimmed potato is put into stripper which operates merely by pushing a lever forward and backward. | Table $3' \times 10'$ Strip cutters mounted on trimming table 5 @ \$25. | 75.00 \$ 125.00 |
| Boiling | 1 M | Potatoes are stripped into water trough under table. | Wooden water trough and equipment to remove potatoes from water | |
| Blanching | | 4 minute blanch. Loading 2 lbs. per sq. foot. Man removes potatoes from water trough and carries them on blancher belt. About 5 lbs. per minute are handled at this rate. | Wire belt blancher, over all length, 10' blancher area, $12' \times 10'$, width $\frac{1}{2}$ h.p. motor | |

| Operation | Charge | Work Area | Description | Per Unit |
|--------------------------|--------|--|--|----------|
| Washing | 1 M | Strips are spread on trays and trays are stacked on cars. | Tray table 3' x 3' trays should be used. | \$ 1.00 |
| Blanching | 1 M | Operation takes about 2½ minutes. Man doing this also loads drier. | | |
| Drying | | Foreman regulates drier. | | |
| Scraping | 1 F | 2 people inspect and scrape trays, then package and crate product. Together they can unload a car in about 30 minutes, or about ¼ the time required to load a car. | Table and bin Scales, table and scaling equipment | |
| Packaging | 1 M | The remainder of time, until next car comes out of drier, can be spent in packaging. | | |
| Preparing for Working | | | | |
| | 1 M | Foreman. | | |
| | 1 H | Helper, cleanup, washing trays and maintenance. | | |
| | | | Sub-total | |
| | | Add 40% for installation and accessory equipment | | |
| | | | Total | \$ 11.20 |
| | | Equipment cost per ton handled per 24-hr. day (unprepared basis). | | \$ 1.00 |
| (Labor Cost) | | Total Labor Requirements: | Total Labor Cost Per | |
| | | 6 women @ 60¢ per hour | \$ 3.60 | |
| | | 5 men @ 75¢ per hour | 3.75 | |
| | | 1 foreman | 1.00 | |
| | | Labor cost per wet pound (40 pounds) | | |
| | | Labor cost per dry pound (57 pounds) | | |
| Steam Generating | | About 10 boiler horsepower required for blanching. Cost estimated on basis of rated horsepower | Approx. cost. | |

SWEET POTATOES
RECEIVING, WASHING, PEELING, TRIMMING,
BLANCHING, DRYING

A FABRICATION PLANT: CAPACITY OF FORTY-THREE TONS PER DAY

Unprepared Basis

| Operation | Time | Employees | Work Done | Equipment Necessary | |
|--------------------------|------|-----------|---|--|-----------------|
| | | | | Description | Approx. Cost |
| RECEIVING | 1 M | 2 | Street potatoes are trucked from receiving platform, | Hand truck | \$ 15. |
| WASHING | | | placed on a screen and washed with a hose. | Washing equipment | 25. |
| | | | After washing, sweet potatoes are put into baskets and hoisted into boiling water for a 10 minute scald. | Wooden vat with steam pipes, hoist, etc. | 150. |
| PEELING | | | Sweet potatoes are dumped from baskets into batch peeler. From peeler they are fed to trimming table on a chute. | Batch peeler with $\frac{1}{2}$ h.p. motor | 225. |
| TRIMMING AND DRESSING | 3 F | | Sorting and trimming is done on a table. | Table 3' x 6" | 50. |
| BLANCHING | 1 M | | Trimmed sweet potatoes are placed in boxes and man carries them to slicer. | Slicer with $\frac{1}{2}$ h.p. motor | 475. |
| BLANCHING | | | Sprays on front end of blancher. Included in blancher cost. | | |
| | | | 6 minute blanch. Loading, 2 lbs. per sq. foot. Man who operates slicer spreads potatoes on blancher belt. | Wire belt blancher, over-all length, 23'. Covered area, 12" x 15", with $\frac{1}{2}$ h.p. motor | |
| | | | 1 M: Slices are spread on trays and trays stacked on cars. Operation takes about $2\frac{1}{2}$ minutes. Man doing this also loads drier. | Tray table | |
| | | | Foreman regulates drier. | trays should be used | |

APPENDIX D - Cost Analysis

Equipment Investment

| Operation | Hours | Work Done | |
|----------------------------------|-------|---|---|
| Scraping | 1 F | 2 people inspect and scrape trays, then package and crate product. Together they can unload a car in about 30 minutes, or about $\frac{1}{4}$ the time required to load a car. The remainder of time, until next car comes out of drier, can be spent in packaging. | Tables and bins \$ 50. |
| and Preparing for Shipping | 1 M | | Scales, tables and sealing equipment \$ 100. |
| | 1 M | Foreman. Helper, cleanup, washing trays and maintenance. | |
| | | Add 40% for installation and accessory equipment | Sub-total \$ 2,140. |
| | | Equipment cost per ton handled per 24-hr. day (unprepared basis.) | Total |
| Labor Cost | | Total Labor Requirements: 4 women @ 60¢ per hour 5 men @ 75¢ " " 1 foreman | Total Labor Cost \$ 2.40 \$ 3.75 \$ 1.25 |
| | | Labor cost per wet pound (400 pounds) | |
| | | Labor cost per dry pound (89 pounds) | |
| Steam Generating | | About 15 boiler horsepower required for scalding and blanching. Cost estimated on basis of rated horsepower. | Approx. Cost |

COSTS
OF TURNIP
WASHING, PEELING,
BLANCHING, DRYING,
AND STACKING

Labor Requirements

In a Dehydration Plant Capable of Handling 400 Pounds per Day.

Unprepared Basis

| Operation | Employees | Work Done | Equipment Necessary | | |
|------------------------------|-----------|--|---|-------|-----------------|
| | | | Description | | Approx. Cost |
| | | | | | |
| Washing and Peeling | 1 M | <ul style="list-style-type: none"> : Man trucks turnips from receiving platform, washes them on a screen, and places them in peeling machine. | <ul style="list-style-type: none"> : Hand truck | \$ 15 | |
| Peeling | | <ul style="list-style-type: none"> : Turnips are conveyed from peeler to trimming table on a chute | <ul style="list-style-type: none"> : Washing equipment | | 25 |
| Peeling and Trimming | 3 F | <ul style="list-style-type: none"> : Topping and trimming done on a table. | <ul style="list-style-type: none"> : Batch peeler with $\frac{1}{2}$ h.p. motor : Table | | 225. |
| Peeling | 1 M | <ul style="list-style-type: none"> : Turnips are taken from table and fed to slicing machine. : Employee doing this also spreads slices on blancher belt. | <ul style="list-style-type: none"> : Slicer with $\frac{1}{2}$ h.p. motor | | 475. |
| Blanching | | <ul style="list-style-type: none"> : Sprays on front end of blancher. Included in blancher cost. | | | |
| Blanching | | <ul style="list-style-type: none"> : 4 minute blanch. Loading on belt, 2 pounds per square foot. | <ul style="list-style-type: none"> : Wire belt : blancher, over-all length 18", covered area, 12" x 11", with $\frac{1}{2}$ h.p. motor | | 1,000. |
| Tray Loading and Stacking | 1 M | <ul style="list-style-type: none"> : Slices are spread on trays and trays are stacked on cars. : Operation takes about $2\frac{1}{2}$ minutes. Man doing this also loads drier. | <ul style="list-style-type: none"> : Tray table : 3" x 3" trays : should be used | | 15. |
| Drying | | <ul style="list-style-type: none"> : Foreman regulates drier | | | |

- VI -
TOMATOES (continued)

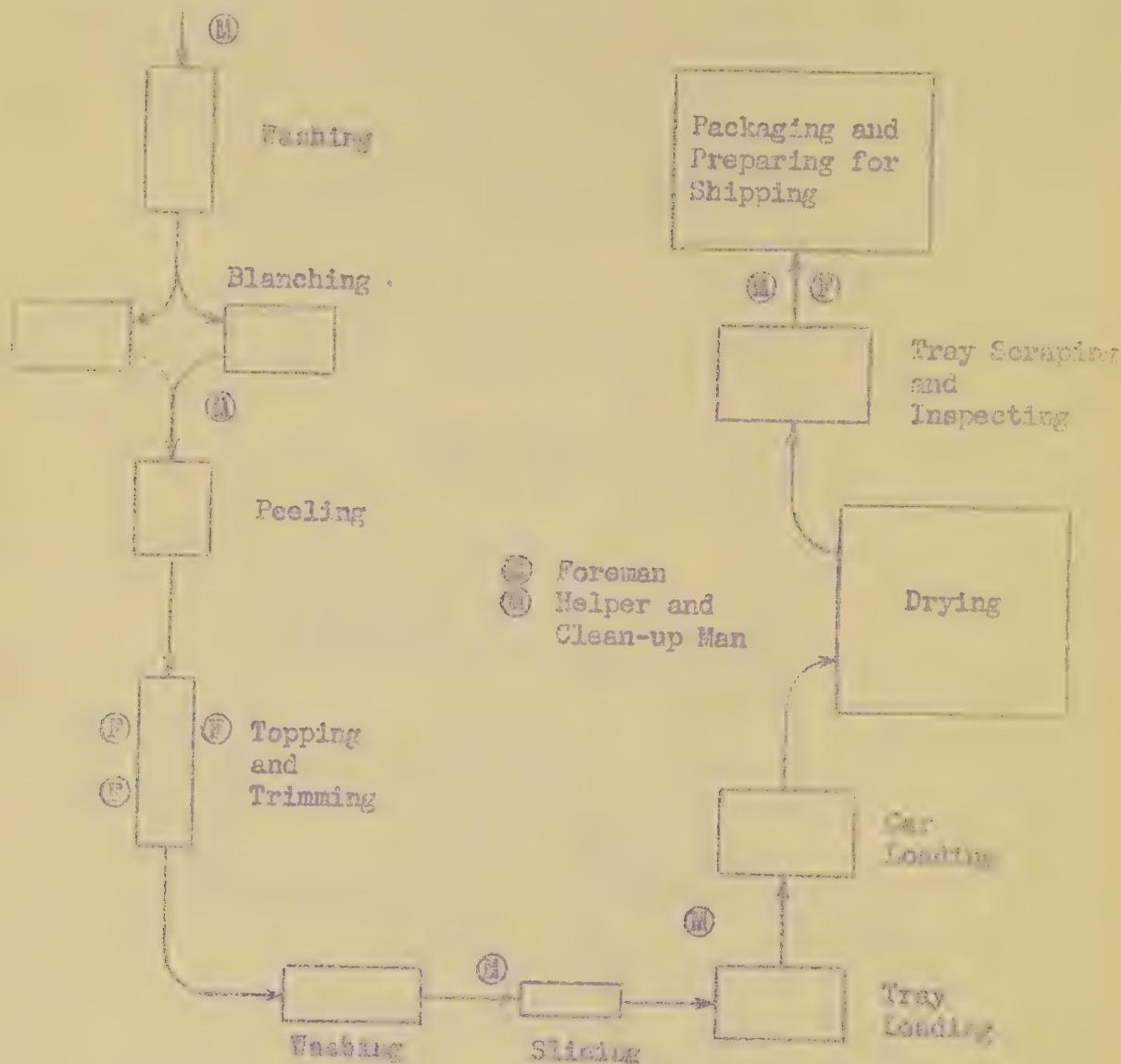
| Operation | Time | Work Done | Equipment Required | Description |
|--|------|---|---|-------------|
| | | | | |
| Scraping Tray , | 1 F | 2 people inspect and scrape | Table and bin | \$ |
| Packaging and Preparing for Shipping | 1 M | trays, then package and crate product. Together, they can unload a car in about 30 min- utes, or about $\frac{1}{4}$ the time re- quired to load a car. The re- mainder of time, until next car comes out of drier, can be spent in packaging. | Scales, table and sealing equipment | |
| General | | Foreman. Helper, cleanup, washing trays and maintenance. | | Sub-total |
| | | Add 40% for installation and accessory equipment | | |
| | | Equipment cost per ton handled per 24-hr day (unprepared basis) | | Total |
| Labor Cost | | Labor Requirements: 4 women @ 60¢ per hour 5 men @ 75¢ " " 1 foreman | Total Labor Cost Per Hour | |
| | | | \$2.40 | |
| | | | 3.75 | |
| | | | 1.00 | |
| | | Labor cost per wet pound (400 pounds) | | |
| | | Labor cost per dry pound (40 pounds) | | |
| Steam Generating | | About 10 boiler horsepower required for blanching. Cost estimated on basis of rated horsepower. | Approx. Cost | |

DEHYDRATION FLOW SHEET

400 Pounds per Hour

Unprepared Basis

Feeding to line



Labor estimate per shift:

| | | |
|---------|---|---|
| Foremen | - | 1 |
| Men | - | 6 |
| Women | - | 4 |

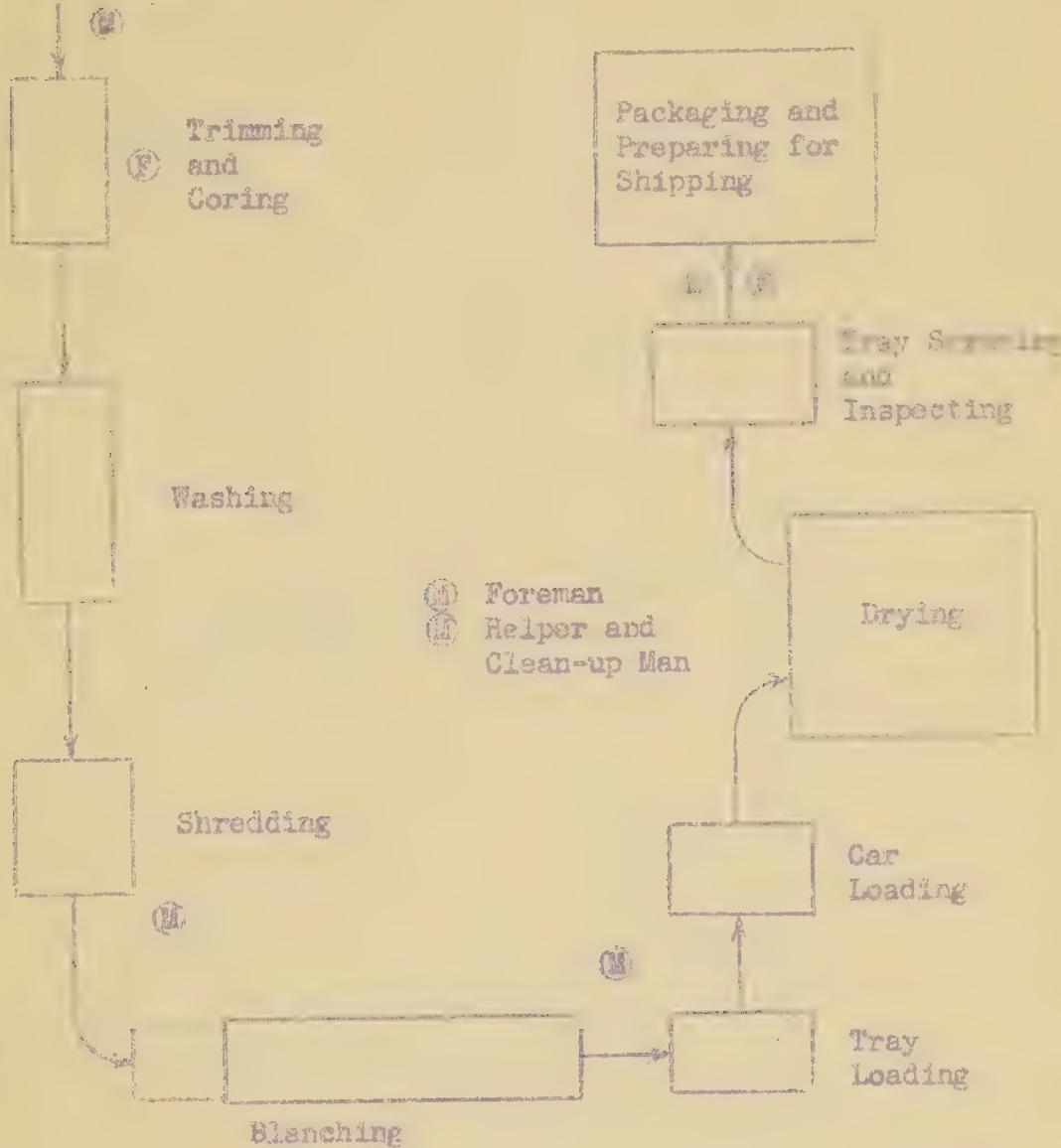
DEHYDRATOR

DEHYDRATION FLOW SHEET

400 Pounds per Hour

Unprepared Basis

RAW MATERIALS



Labor estimate per shift:

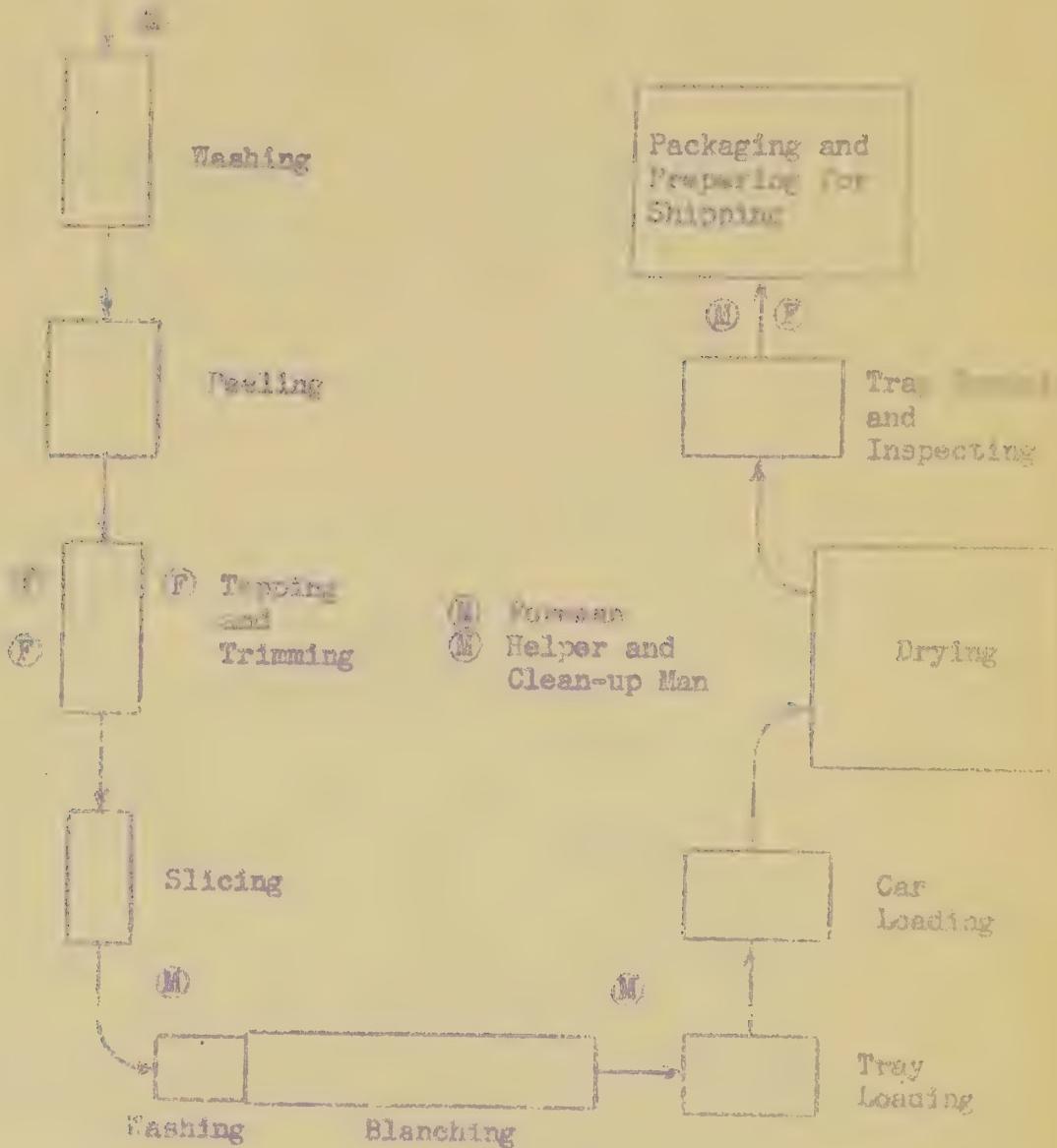
| | | |
|---------|---|---|
| Foremen | = | 1 |
| Men | = | 5 |
| Women | = | 2 |

DEHYDRATION FLOW SHEET

400 Pounds per Hour

Unprepared Basis

Feeding to line



Labor estimate per shift:

| | | |
|---------|---|---|
| Foremen | = | 1 |
| Men | = | 5 |
| Women | = | 4 |

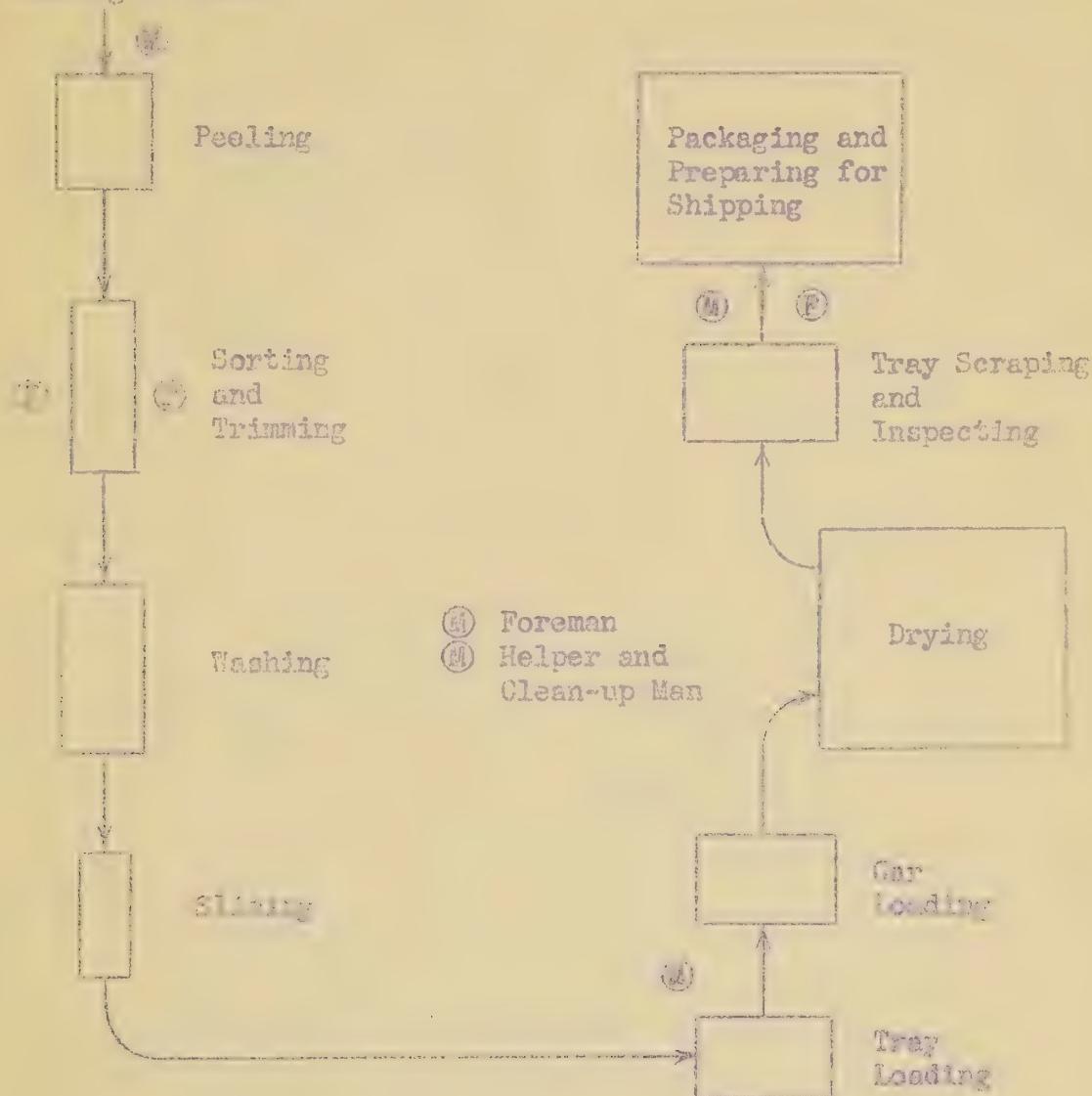
ON WORK

DEHYDRATION FLOW SHEET

400 Pounds per Hour

Unprepared Basis

Feeding to line



Labor estimate per shift:

| | |
|-----------|---|
| Foremen - | 1 |
| Men - | 4 |
| Women - | 3 |

Prepared by the Dehydration Committee,
 Bureau of Agricultural Chemistry and
 Engineering, United States Department
 of Agriculture, August 1942.

400 Pounds per Hour

Unprepared Basis

Labor estimate per shift:

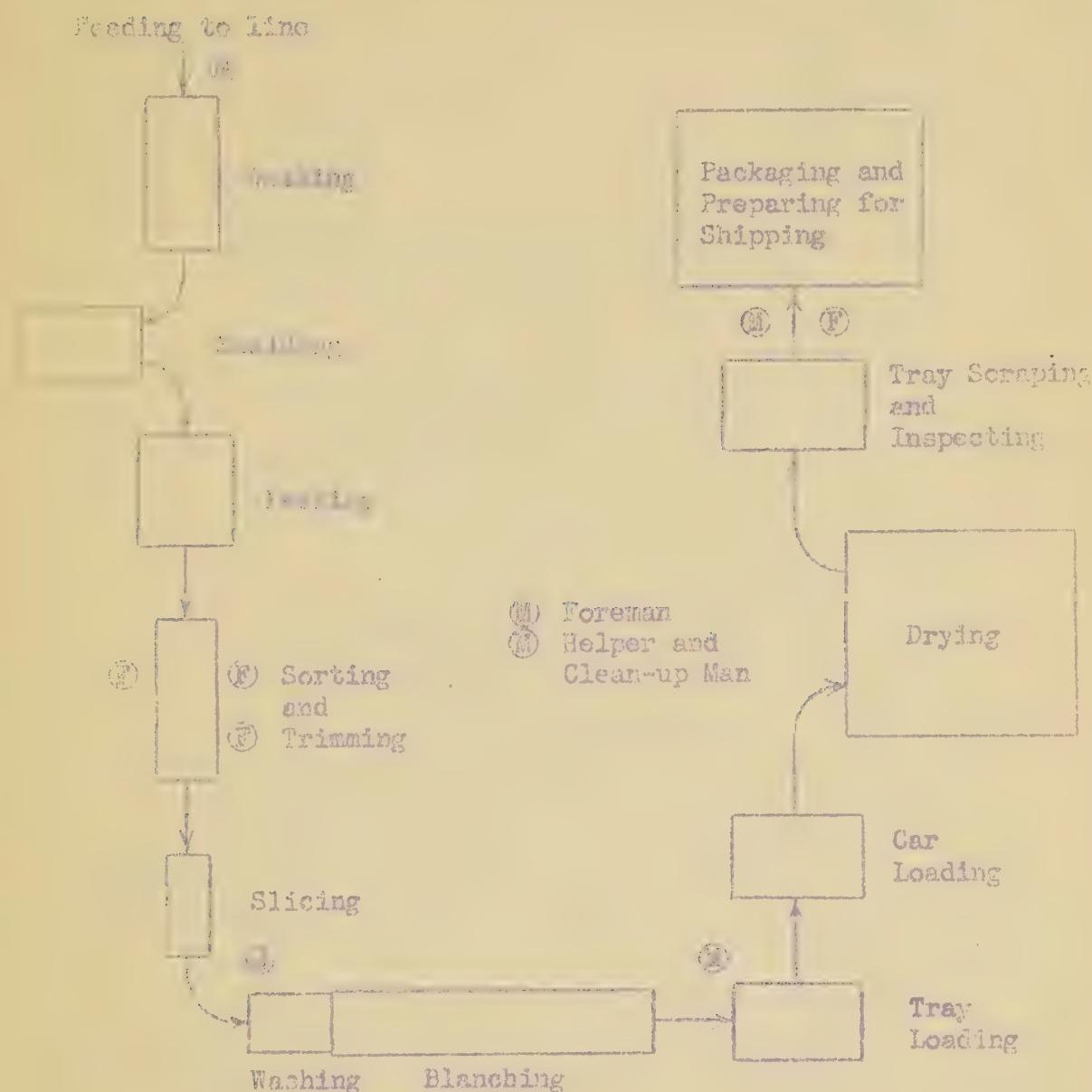
| | | |
|---------|---|---|
| Foremen | - | 1 |
| Men | - | 5 |
| Women | - | 6 |

Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

DEHYDRATING FLOW CHART

400 Pounds per Hour

Unprepared Basis



Labor estimate per shift:

| | | |
|---------|---|---|
| Foremen | - | 1 |
| Men | - | 5 |
| Women | - | 4 |

Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

VENTILATION FLOW SHEET

400 Pounds per Hour

Unprepared Basis

Feeding to Live

Labor estimate per shift:

| | |
|---------|---|
| Foremen | 1 |
| Men | 2 |
| Women | 4 |

Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture.

If further detailed information is
desired, inquiries should be addressed
to:

The Dehydration Committee
Bureau of Agricultural Chemistry
and Engineering
U. S. Department of Agriculture
Washington, D. C.

or to

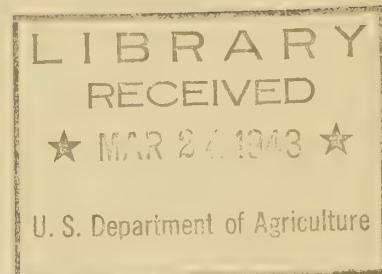
The Dehydration Committee
Bureau of Agricultural Chemistry
and Engineering
U. S. Department of Agriculture
800 Buchanan Street
Albany, California



Dehydration Committee
Bureau of Agricultural Chemistry and Engineering
U. S. Department of Agriculture

ESTIMATES OF EQUIPMENT COSTS AND LABOR REQUIREMENTS
IN
VEGETABLE DEHYDRATION

Plant Capacity--830 Pounds Per Hour
(Unprepared Basis)



Preparation, final inspection and packaging equipment are the only types of equipment considered in this report. All labor requirements except clerical and shipping are included.

August 1942

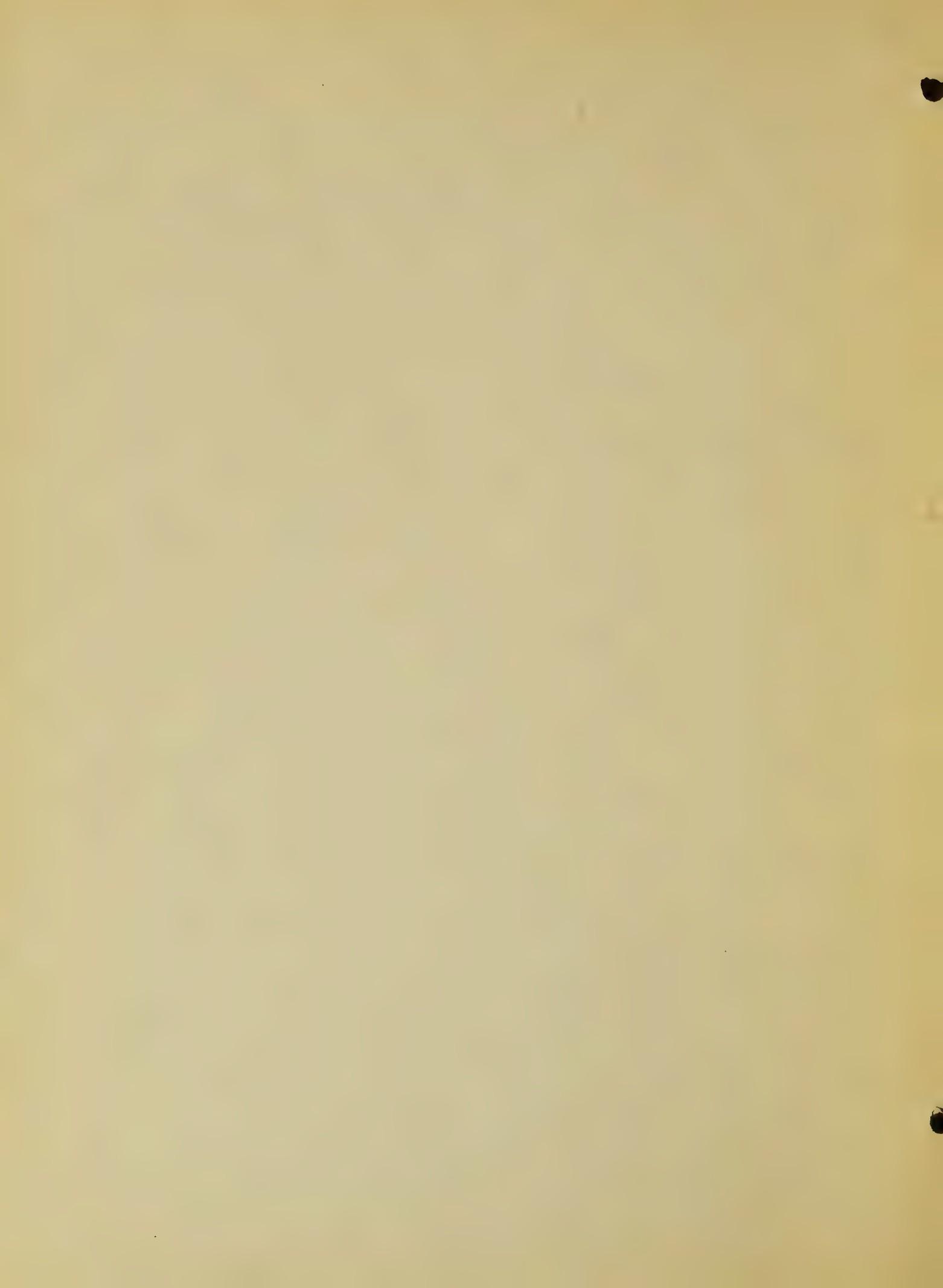


TABLE OF CONTENTS

| | |
|--|----|
| GENERAL DISCUSSION..... | 1 |
| SUMMARY OF EQUIPMENT AND LABOR COSTS..... (For seven vegetables important in dehydration) | 5 |
| GAPACITIES PER UNIT OF TIME..... (For seven vegetables important in dehydration) | 6 |
| PREPARATION, FINAL INSPECTION, AND PACKAGING EQUIPMENT, AND LABOR REQUIREMENTS: | |
| Beets..... | 8 |
| Cabbage..... | 10 |
| Carrots..... | 12 |
| Onions..... | 14 |
| Potatoes..... | 16 |
| Sweet Potatoes (Yams)..... | 18 |
| Turnips (Rutabagas)..... | 20 |
| FLOW SHEETS: | |
| Beets..... | 22 |
| Cabbage..... | 23 |
| Carrots..... | 24 |
| Onions..... | 25 |
| Potatoes..... | 26 |
| Sweet Potatoes (Yams)..... | 27 |
| Turnips (Rutabagas)..... | 28 |



and Labor Requirements
Vegetable Dehydration at a Plant Capacity of 330 Pounds per Hour,
Unprepared Basis

This discussion deals with preparation and packaging equipment costs and labor requirements in dehydration plants capable of handling 330 pounds per hour, unprepared basis. It is apparent that the tonnage handled is directly proportional to the length of the operating day. The same preparation equipment is, therefore, required in a batch type plant of 5 tons daily capacity, if the preparation line operates only twelve hours per day, as in a continuous plant of 10 tons daily capacity. The vegetables considered are:

| | | |
|-------------|----------|-----------------------|
| Table Beets | Carrots | Sweet Potatoes (Yams) |
| Cabbage | Onions | Turnips (Purtsbegees) |
| | Potatoes | |

Costs of equipment and labor for vegetable drying are subject to wide variation. The ability to improvise certain items may permit substantial savings in plant investment as compared to a plant using standard cannery equipment. Proper plant layout may even eliminate some items. The balance between labor and machinery is a very important factor. The initial cost of a labor-saving machine may be large, but the labor cost saved may be much larger than capital and operating charges on the machine. Relative availability of labor and machinery may determine the proportion of labor and machine operation in a plant.

Equipment listed herein and indicated methods of operation are intended to be merely suggestive. Other items of equipment as well as other operating procedures may be equally satisfactory or even better. For instance, mechanical abrasive peelers have been assumed. Lye peeling, if permitted, by purchase specifications, may be preferable on carrots, potatoes, and other hard root vegetables. Other peeling methods, for example, carbonization by flame or radiant heat, followed by vigorous scrubbing, have also shown promise on an experimental basis. Carrots, turnips, and beets are shown as being peeled before topping. Under certain conditions it may be advisable to do the topping before peeling and the trimming after peeling. Standard abrasive peelers have not proven entirely satisfactory on certain vegetables. Manufacturers have adopted various expedients to overcome this difficulty.

Costs and descriptions of equipment are based upon prices and information from established manufacturers in this field. The labor set-ups shown are based upon cannery operations and the operations of present commercial dehydrators. They will vary appreciably from plant to plant. If the items of equipment or sequence and methods of operations are different from those given here, the labor set-up

must be modified accordingly.

The processing tables will only major items of equipment needed in the preparation of vegetables for drying and in the final inspection and packaging of the dried product. It is assumed that other items of equipment such as graders and spray washers may be improvised and that items such as elevators and conveying belts will be replaced by transport type tables because of the small size of the plant. Some handling of boxes can be eliminated by placing the batch type peeler closer to the blanching table and by providing a discharge chute from the peeler to the table. The washer may be applied into the peeler in a similar manner.

Plant operators have the tendency to over-peel smaller size vegetables and under-peel larger ones. Hence it is preferable to put only carrots through the peeler at a time. This involves the use of a grader or some form of the purchase of pre-ground vegetable. The latter might be particularly expedient in a small plant. A simple flat grader may be built at the plant at a cost which is only a small fraction of the cost of a commercially built grader.

A steam spray at the beginning of the blancher tank is quite satisfactory in washing the diced, sliced, or stripped vegetables. A separate washer to do the same work may cost several hundred dollars. If the washer is omitted, the services of another employee may be required. Such a water spray at the front end of a blancher tank tends to prevent condensation humidity in the preparation room by condensing steam escaping from this end of the blancher.

The amount of steam necessary for blanching will vary from plant to plant depending upon losses from the blancher and care in the avoidance of waste storage. The range may be from 1 to 3 boiler horsepower for each ton of unprepared vegetables handled per 24-hour period. Except for sugar beets and sweet potatoes, a requirement of 2 boiler horsepower per ton per day has been assumed. Due to recent blanching used for beets, a slightly larger amount is considered necessary. Sweet potatoes are considered as small as planned. Due to their double heating, they require somewhat more steam capacity. The plant operator can lessen the investment in steam boilers by insuring proper plant operation to minimize the steam losses and by operating the steam boiler above its rated capacity.

No provision for waste disposal equipment has been made in these estimated costs. Since disposal of waste is a very important and expensive costly factor, it cannot be overlooked in setting up a plant. Such plants may have its own methods of waste disposal, but it is probable that in the case of potatoes and sweet potatoes, the most common method will involve carrying of wastes from the plant by water. This will necessitate a method of separating suspended solid from the water by screening, settling, or otherwise. These solids may be buried

composted, incinerated, or processed for byproduct values. The liquid effluent may be sent to a sewer, a cesspool, or to other places of disposal. Other vegetables which may be heated may, burned, or treated for byproduct recovery, but will usually involve a less serious disposal problem. Each of these methods will be subject to sanitary regulations. Due to the new Federal laws, no attempt is being made at this time to show the cost of each method. Economical disposal of preparation wastes will usually require some ingenuity on the part of plant operators.

The cost of packaging equipment is based on the assumed use of 5-gallon cans. Recent practice has been to solder the top after filling the can with inert gas. A regulator valve for the gas, relatively inexpensive packaging equipment, and scales are the main items needed for this type of packaging. Other types of packaging might involve a larger capital investment. Automatic can sealers have been recently introduced. These use a plastic sealing material under the edge of the lid which eliminates the necessity for soldering. No increased capital investment is ordinarily involved in the use of the automatic can sealer since the machine is leased to the user. In a small plant such as the one considered here, it is questionable if the use of such a can sealer could be economically justified on the basis of cost alone.

Only one form of prepared vegetable has been considered. Preparation of vegetables in other forms will necessitate the installation of other types of machinery and usually entail an increase in cost. The labor factor may also be affected to some extent by resulting differences in blancher loading, tray loading, and drying time.

It is estimated that installation costs will account to from 10 to 30% of the purchase price of the machinery. Valves, piping, wiring, tanks, hoses, scales, tools, and other accessory equipment plus some allowances for improvised items may account to an additional 20 to 40%. Together these make a total of about 50% to be added to the purchase price to cover costs of installation and accessory items.

In placing the prepared material on the trays for drying and also in spreading the material on the blancher belt, it is necessary to have it spread uniformly over the surface. This allows for proper air circulation and avoids lumps which may not dry. In blanching, a uniform spread insures adequate penetration of heat to all places of the vegetable. An automatic device for doing this spreading will reduce the number of employees needed at these points.

The number of women that are employed on the sorting and trimming tables will have a marked effect on the operation of the plant. As the number of women increases, more time will be spent on each potato or other vegetable, thus reducing waste and insuring a better quality product. General sorting and trimming will decrease the amount of trash or trash discarded in the final inspection, decrease the likelihood of animal rejection, and probably decrease the number of employees needed for the final inspection. There will, however, be an optimum

point for the most economical operation of the plant in obtaining an acceptable product.

It is assumed that the work was shown in the accompanying tables will assist in actual processing of the material, in care and operation of the equipment, and in removal of waste from the plant. It has not been indicated on the timetables if a man performs more than one operation. Due to the small size of plant, many of the employees will have to do several operations in order to utilize their time most efficiently.

Since actual working time in an 8-hour shift may be only 7 hours, the indicated hourly capacities are only intended to be an average of quantities handled during an 8-hour shift. Quantities handled in any one hour of actual operation will have to be slightly higher if the assumed rate of production is to be maintained throughout a complete shift. The number of employees indicated should, as a rule be sufficient to cover this difference.

SUMMARY OF COSTS

Preparation, Final Inspection, and Packaging Equipment,
and Labor Requirements in
Vegetable Dehydration at a Plant Capacity of 830 Pounds per Hour

Unprepared Basis

| Name of Vegetable | Shrinkage | Equipment Cost | | | Labor Cost | | |
|-------------------|-----------|----------------|-------|-----------|------------|---------|----|
| | | Per Ton 1/ | | Wet : Dry | Per Pound | | |
| | | Ratio | Total | | (Unpre- | (unpre- | |
| | | : | : | | :pared) | :pared) | : |
| | | | | \$ | \$ | \$ | \$ |
| Tomato Slices | 13 to 1 | 3,762. | 377. | 4,895. | 1.48 | 19.1 | |
| Mushrooms | 19 to 1 | 4,065. | 437. | 7,724. | 1.31 | 24.2 | |
| Cornrels | 10 to 1 | 4,440 | 434. | 4,440 | 1.46 | 21.6 | |
| Onions | 14 to 1 | 2,640. | 264. | 3,696. | 1.13 | 15.5 | |
| Potatoes | 7 to 1 | 5,365 | 537. | 4,106. | 1.80 | 12.6 | |
| Small Potatoes | 4½ to 1 | 5,215 | 512 | 2,302. | 1.60 | 7.2 | |
| Carrots | 10 to 1 | 6,410. | 641. | 6,410. | 1.53 | 15.3 | |

1/ Equipment cost per ton handled per 24-hour day.

Capacities per Unit of Time
In a Vegetable Dehydration Plant
Capable of Handling 830 Pounds per Hour

(Unprepared Basis)

| Form Prepared | Beets | Cabbage | Carrots | Onions | Potatoes | Turnips & Celeriac | Sweet (Yams) | Others |
|--|--------|---------|---------|--------|----------|--------------------|--------------|--------|
| | Slices | Slices | Slices | Slicer | Strip. | 14 | 14 | 14 |
| <u>Unprepared basis:</u> | | | | | | | | |
| Tons per 24-hour day | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Pounds per 24-hour day | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 |
| Pounds per hour | 830 | 830 | 830 | 830 | 830 | 830 | 830 | 830 |
| Pounds per minute | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| No. of women coring | | | 2 | | | | | |
| Pounds per woman per hour | | | 415 | | | | | |
| Pounds per woman per minute | | | 6.9 | | | | | |
| Number of retorts | | 2 | | | | | | |
| Blanching time in minutes | | 10 | | | | | | |
| Minutes per charge per retort - loading, blanching & unloading | | 20 | | | | | | |
| Charges per hour | | 6 | | | | | | |
| Pounds per charge | | 140 | | | | | | |
| Cars or crates per charge | | 3 | | | | | | |
| Pounds per car or crate | | 46 | | | | | | |
| <u>Prepared basis:</u> | | | | | | | | |
| Assumed preparation loss | 20% | 25% | 25% | 25% | 20% | 25% | 25% | 25% |
| Tons per 24-hour day | 7.0 | 7.5 | 7.5 | 7.5 | 7.0 | 7.5 | 7.5 | 7.5 |
| Pounds per 24-hour day | 14,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 |
| Pounds per hour | 580 | 600 | 600 | 710 | 630 | 670 | 670 | 670 |
| Pounds per minute | 9.7 | 10.2 | 10.2 | 11.8 | 10.4 | 11.1 | 11.1 | 11.1 |
| Number of women sorting, topping and trimming | 5 | | 5 | 4 | 10 | 6 | 5 | 5 |
| Pounds per woman per hour | 115 | | 125 | 175 | 65 | 105 | 135 | 135 |
| Pounds per woman per minute | 1.9 | | 2.1 | 3.0 | 1.0 | 1.7 | 2.2 | 2.2 |
| <u>Assumed blancher loading -</u> | | | | | | | | |
| lbs. per square foot | | 1.3 | 2.0 | | 2.0 | 2.0 | 2.0 | 2.0 |
| Assumed blanching time in minutes | | 3 | 4 | | 4 | 6 | 4 | 4 |
| Pounds in blancher at any one time | | 31 | 42 | | 42 | 63 | 44 | 44 |
| Square feet of blancher needed | | 21 | 21 | | 21 | 32 | 22 | 22 |
| <u>Assumed try loading -</u> | | | | | | | | |
| lbs. per square foot | 1.5 | 1.2 | 1.5 | 1.2 | 1.5 | 1.5 | 1.5 | 1.5 |
| Pounds per car | 590 | 475 | 590 | 475 | 590 | 590 | 590 | 590 |

Capacities per Unit of Time
In a Vegetable Dehydration Plant

(Unprepared Basis)

| | Beets | Cabbage | Carrots | Onions | Potatoes | Sweet Potatoes (Yams) | Turnips |
|-----------------------|---------|---------|---------|---------|----------|-----------------------|---------|
| Prepared | Slices | Shreds | Slices | Slices | Strips | Slices | Slices |
| per hour | 24 | 32 | 25 | 36 | 25 | 25 | 27 |
| s per hour | 1.0 | 1.3 | 1.0 | 1.5 | 1.0 | 1.0 | 1. |
| s per minute | 61 | 45 | 57 | 40 | 57 | 57 | 53 |
| s per minute | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| s per minute | 27 | 21.6 | 27 | 21.6 | 27 | 27 | 27 |
| s per minute | 520 | 690 | 560 | 790 | 560 | 560 | 590 |
| s per minute | 22 | 29 | 23 | 33 | 23 | 23 | 25 |
| s per minute | 0.37 | 0.48 | 0.38 | 0.55 | 0.38 | 0.38 | 0.4 |
| s per minute | 160 | 125 | 160 | 110 | 160 | 160 | 145 |
| net overall shrinkage | 13 to 1 | 19 to 1 | 10 to 1 | 14 to 1 | 7 to 1 | 4½ to 1 | 10 to 1 |
| s per hour | 3,560 | 1,370 | 2,000 | 1,450 | 2,360 | 4,440 | 2,000 |
| s per minute | 65 | 45 | 85 | 60 | 120 | 185 | 85 |
| s per minute | 1.1 | 0.73 | 1.4 | 1.0 | 2.0 | 3.1 | 1.4 |
| for 5-gallon can | 10 | 5 | 14 | 9 | 10 | 13 | 6 |
| 24-hour day | 250 | 210 | 140 | 160 | 285 | 340 | 335 |
| s per hour | 6.5 | 8.3 | 5.8 | 6.7 | 11.9 | 14.2 | 14.0 |
| ites per can | 9.2 | 6.8 | 10.3 | 9.0 | 5.0 | 5.2 | 4.3 |

TABLE SEVENTEEN
 Preparation, Final Inspection and Packaging Equipment, and
 Labor Requirements
 In a Dehydration Plant Capable of Handling 830 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> | |
|--|---|-------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| Feeding to Preparation Line | | |
| Washing | Rotary bar washer Drum size - 25" x 6' With 1 h.p. motor | \$ 450. |
| Blanching - 10 minutes at 5 pounds pressure in retorts | 2 Small retorts with 3 crates each with pulleys and hoists | 700. |
| Peeling | Batch peeler With 1½ h.p. motor | 600. |
| Topping and Trimming | Table - 3' x 10' | 75. |
| Washing | Vat or trough | 50. |
| Slicing | Slicer With $\frac{1}{2}$ h.p. motor | 475. |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | |
| Moving Cars and Drying | | |
| Scraping Trays | Table top over bin | 100. |
| Final Inspecting | Inspection done by employees scraping trays. | |
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | |
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | |
| Sub-total | | |

TABLE BEETS (continued)

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|---|---|--|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| Sub-total | | \$2,510. |
| a 40% for installation and accessory equipment; 50% for same plus improvised items | 50% | <u>1,255.</u> |
| Total | | <u>\$3,765.</u> |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | \$ 377. |
| Labor Cost per Pound - (13 to 1 overall shrinkage ratio) (Based on 16 lbs labor cost per hour) | 5 Women @ 60¢ per hour 11 Men @ 75¢ " " 1 Foreman Labor cost per hour (330 lbs) | \$3.00 8.25 1.00 \$ 12.25 1.48¢ |
| Steam Generating - Approximate Boiler Horsepower Needed - (2½ b.h.p. per ton per day) For blanching only. Approximate Cost of Boiler if operated at Rated Capacity | 25 b.h.p. \$2,500. | |

CABBAGE

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements
In a Dehydration Plant Capable of Handling 830 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> | <u>Description of Equipment</u> | <u>Cost</u> |
|---|------------------|--|--------------------|
| Feeding to Preparation Line | | Equipment for feeding to the line will probably have to be improvised for this size plant | \$ 500. |
| Trimming and Coring | | Table - 3' x 6' 2 improvised cabbage corers With $\frac{1}{2}$ h.p. motor Located over table | 50. 2 p 125. |
| Washing | | Rotary bar washer Drum size - 25" x 6" With 1 h.p. motor | 450. |
| Shredding | | Kraut cutter 21" disc With $\frac{1}{2}$ h.p. motor | 225. |
| Spreading on Blancher Belt | | | 1 p |
| Blanching, 3 Minutes - Loading on blancher belt, 1 $\frac{1}{2}$ pounds per square foot | | Wire belt blancher Overall length - 18' Covered area - 24" x 11' With 1 h.p. motor | 1,200 |
| Tray Loading and Stacking | | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | |
| Moving Cars and Drying | | | |
| Scraping Trays | | Table top over bin | 100. 2 m |
| Final Inspecting | | Inspection done by employees scraping trays. | |
| Packaging and Preparing for Shipping | | Scales, table, and sealing equipment | |

CABBAGE (continued)

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|--|--|----------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| General - Foreman | | 1 M |
| Helpers, cleanup, washing trays, and maintenance | | 2 M |
| | Sub-total | \$2,710. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items | 50% | <u>1,355.</u> |
| | Total | <u>\$4,065</u> |
| Equipment Cost per Ton Handled per 24-hour Day (Unprepared Basis) | | <u>\$ 407.</u> |
| | | |
| Labor Cost per Pound - (2 to 1 overall shrinkage ratio) (based on the labor cost per hour) | 4 Women @ 60¢ per hour \$ 2.40 10 Men @ 75¢ " " 7.50 1 Foreman 1.00 Labor cost per wet pound (830 lbs) | 2 10.90 |
| | Labor cost per dry pound (44 lbs) | 1.316 |
| | | 24.8 C |
| Steam Generating - Approximate | | |
| Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blanching only. | 20 b.h.p. | |
| Approximate Cost of Boiler if Operated at Rated Capacity | | \$2,100. |

CARROTS

Preparation, Final Inspection and Packaging Equipment and
Labor Requirements
for a Blanching Plant Capable of Handling 150 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> <u>Description of Equipment</u> | <u>Cost</u> | <u>Labor</u> |
|--|---|-------------|--------------|
| Feeding to Preparation Line | | | 1 M |
| Washing | Rotary bar washer Drum size - 25" x 6' With 1 h.p. motor | \$ 450. | |
| Peeling | Batch peeler With 1½ h.p. motor | 600. | |
| Cutting and Trimming | Table - 3' x 10' | 75. | 5 F |
| Slicing | Slicer With ½ h.p. motor | 475. | 1 M |
| Spreading on Blancher Belt | | | 1 F |
| Washing | Sprays on front end of blancher. Included in blancher cost. | | |
| Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 18' Covered area - 24" x 11' With 1 h.p. motor | 1,200. | |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | | 2 M |
| Moving Cars and Drying | | | 1 M |
| Scraping Trays | Table top over bin | 100. | 2 M |
| Final Inspecting | Inspection done by employees scraping trays. | | |
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | 60. | 1 M |

CARROTS (continued)

| <u>Operation</u> | <u>Equipment</u> | <u>Labo</u> |
|--|--|------------------------------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| General - Foreman | | 1 1 |
| Helpers, cleanup, tray washing, and maintenance | | 2 1 |
| | Sub-total | \$2,960 |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | | |
| | Total | 50% 1,480. <u>\$4,440.</u> |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | <u>\$ 4440.</u> |
| Labor Cost per Pound - (10 to 1 overall shrinkage ratio) (based on the labor cost per hour) | 6 Women @ 60¢ per hour \$ 3.60 10 Men @ 75¢ " " 7.50 1 Foreman 1.00 <u>22.10</u> | 1.46¢ |
| | Labor cost per wet pound (630 lbs) | |
| | Labor cost per dry pound (83 lbs) | 14.6 ¢ |
| Steam Generating - Approximate | | |
| Boiler Horsepower Needed - (2.5 b.h.p. per ton per day) For blanching only. | 20 b.h.p. | |
| approximate Cost of Boiler if Operated at Rated Capacity | | \$2,100. |

ONIONS

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements

In a Dehydration Plant Capable of Handling 850 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> <u>Description of Equipment</u> | <u>Cost</u> | <u>Labor</u> |
|--|--|-------------|--------------|
| Feeding to Preparation Line | | | 1 M |
| Peeling | Batch peeler With 1½ h.p. motor | \$ 600. | |
| Sorting and Trimming | Table - 3' x 10' | 75. | 4 F |
| Washing | Rotary bar washer Drum size - 25" x 6' With 1 h.p. motor | 450. | |
| Slicing | Slicer With $\frac{1}{2}$ h.p. motor | 475. | |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | | 2 M |
| Moving Cars and Drying | | | 1 M |
| Scraping Trays | Table top over bin | 100. | 2 M |
| Final Inspecting | Inspection done by employees scraping trays. | | |
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | 60. | 1 M |
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | | 1 M |
| | | | 1 M |
| Sub-total | | \$1,760. | |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items | 50% | 880. | |
| Total | | \$2,640. | |

ONIONS (continued)

| <u>Operation</u> | <u>Equipment</u> | <u>Description of Equipment</u> | <u>Cost</u> |
|--|---|---------------------------------|-------------|
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | | \$ 264. |
| Labor Cost per Pound - (14 to 1 overall shrinkage) | 4 Women @ 60¢ per hour 8 Men @ 75¢ " " | \$ 2.40 6.00 | |
| (Based on the labor cost per hour) | 1 Foreman | 1.00 | \$ 9.40 |
| | Labor cost per wet pound (830 lbs) | | 1.13¢ |
| | Labor cost per dry pound (59 lbs) | | 15.9 ¢ |

100-117-2

POTATOES

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements

In a Dehydration Plant Capable of Handling 830 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> <u>Description of Equipment</u> | <u>Labor</u> <u>Cost</u> |
|--|---|-----------------------------|
| Feeding to Preparation Line | | 1 M |
| Washing | Rotary bar washer Drum size - 25" x 6' With 1 h.p. motor | \$ 450. |
| Cutting | It would be advisable to buy pregraded potatoes | |
| Peeling | Batch peeler With 1½ h.p. motor | 600. |
| Cutting and Trimming | Belt conveying sorter Belt size - 30" x 15' With 1 h.p. motor | 10 F |
| Stripping | Strip cutter and slicer With 2 h.p. motor | 800. |
| Spreading on Blancher Belt | | 700. |
| Washing | Sprays on front end of blancher - Included in blancher cost. | 1 F |
| Boiling, 4 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 18' Covered area - 24" x 11' With 1 h.p. motor | 1,200. |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equip- ment. See below. | 2 M |
| Moving Cars and Drying | | 1 M |
| Scraping Trays | Table top over bin | 100. 2 M |
| Final Inspecting | Inspection done by employees scraping trays. | |

POTATOES (continued)

| <u>Operation</u> | <u>Equipment</u> | |
|---|---|-------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | \$ 60. |
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | 1 1 |
| | | 2 1 |
| Sub-total | | \$3,910. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | 50% | 1,955. |
| Total | | \$5,865. |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | \$ 537. |
| Labor Cost per Pound - (1 to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 12 Women @ 60¢ per hour \$ 7.20 9 Men @ 75¢ " " 6.75 1 Foreman 1.00 | 1.92 |
| | Labor cost per wet pound (830 lbs) | 1.80¢ |
| | Labor cost per dry pound (120 lbs) | 12.5 ¢ |
| team Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) for blanching only. | | 20 b.b.p. |
| Approximate Cost of Boiler if Operated at Rated Capacity | | \$2,100. |

SWEET POTATOES

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements

In A Dehydration Plant Capable of Handling 830 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment Description of Equipment</u> | <u>Labor Cost</u> |
|--|--|-------------------|
| Feeding to Preparation Line | | 1 M |
| Washing | Rotary bar washer Drum size - 25" x 6' With 1 h.p. motor | \$ 450. |
| Scalding, 10 Minutes in Boiling Water | Wooden vat with steam pipes, hoist, etc. | 250. |
| Peeling | Batch peeler With 1½ h.p. motor | 1 M 600. |
| Sorting and Trimming | Table - 3' x 10' | 75. 6 F |
| Slicing | Slicer With $\frac{1}{2}$ h.p. motor | 475. |
| Spreading on Blancher Belt | | 1 F |
| Washing | Sprays on front end of blancher - Included in blancher cost. | |
| Blanching, 6 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 24' Covered area - 24" x 16' With 1 h.p. motor | 1,400. |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items, being included as accessory equipment. | 2 M |
| Moving Cars and Drying | | 1 M |
| Scraping Trays | Table top over bin | 100. 2 M |
| Final Inspecting | Inspection done by employees scraping trays. | |

SWEET POTATOES (continued)

| <u>Operation</u> | <u>Equipment</u> | <u>Description of Equipment</u> | <u>Cost</u> |
|---|---|---------------------------------|-----------------|
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | | \$ 60. |
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | | |
| | Sub-total | | \$3,410. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | 50% | | <u>1,705.</u> |
| | Total | | <u>\$5,115.</u> |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | | <u>\$ 512.</u> |
| Labor Cost per Pound ($\frac{1}{2}$ to 1 overall shrinkage ratio) | 8 Women @ 60¢ per hour 10 Men @ 75¢ " " 1 Foreman | \$ 4.80 7.50 1.00 | <u>\$ 13.30</u> |
| (base on the labor cost per hour) | Labor cost per wet pound (830 lbs) | | 1.60 |
| | Labor cost per dry pound (185 lbs) | | 1.60 |
| Steam Generating - Approximate Boiler Horsepower Needed - (3 b. h.p. per ton per day) For scalding and blanching only. | | 30 b.h.p. | |
| Approximate Cost of Boiler if Operated at Rated Capacity | | | \$2,900. |

TURNIPS

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements
in a Dehydration Plant Capable of Handling 830 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> <u>Description of Equipment</u> | <u>Labor</u> <u>Cost</u> |
|--|---|-----------------------------|
| Feeding to Preparation Line | | 1 M |
| Washing | Rotary bar washer Drum size - 25" x 6' With 1 h.p. motor | \$ 450. |
| Peeling | Batch peeler With 1½ h.p. motor | 600. |
| Topping and Trimming | Table - 3' x 10' | 75. 5 F |
| Slicing | Slicer With $\frac{1}{2}$ h.p. motor | 1 M 475. |
| Spreading on Blancher Belt | | 1 F |
| Washing | Sprays on front end of blancher - Included in blancher cost | |
| Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 18' Covered area - 24" x 11' With 1 h.p. motor | 1,200. |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | 2 M |
| Moving Cars and Drying | | 1 M |
| Scraping Trays | Table top over bin | 100. 2 M |
| Final Inspecting | Inspection done by employees scraping trays. | |
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | 60. 1 F 1 M |

TURNIPS (continued)

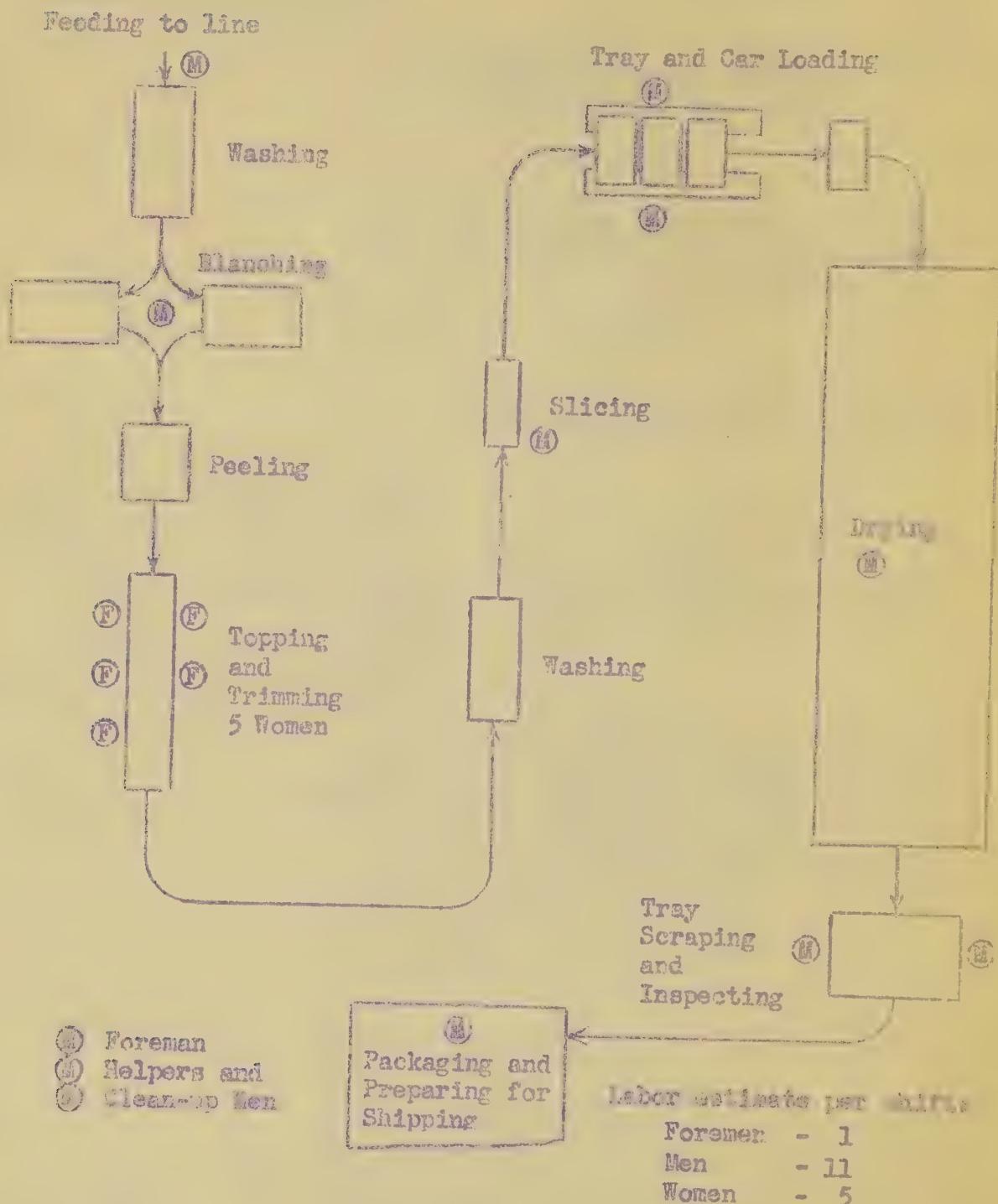
| <u>Operation</u> | <u>Equipment</u> | <u>Description of Equipment</u> | <u>Cost</u> |
|---|---|---------------------------------|-------------|
| General - Foreman | | | |
| Helpers, cleanup, washing trays, and maintenance | | | |
| | Sub-total. | | \$2,150 |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | 50% | | \$2,150 |
| | Total | | \$4,300 |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | | \$2,150 |
| Labor Cost per Pound - (10 to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 7 Women @ 60¢ per hour 10 Men @ 75¢ " " 1 Foreman | \$4.20 7.50 1.00 | \$15.70 |
| | Labor cost per wet pound (830 lbs) | | |
| | Labor cost per dry pound (83 lbs) | | |
| Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blanching only. Approximate Cost of Boiler if Operated at Rated Capacity | | | 20 b.h.p. |

LEWIS

DEHYDRATION FLOW SHEET

630 Pounds per Hour

Unprepared Basis



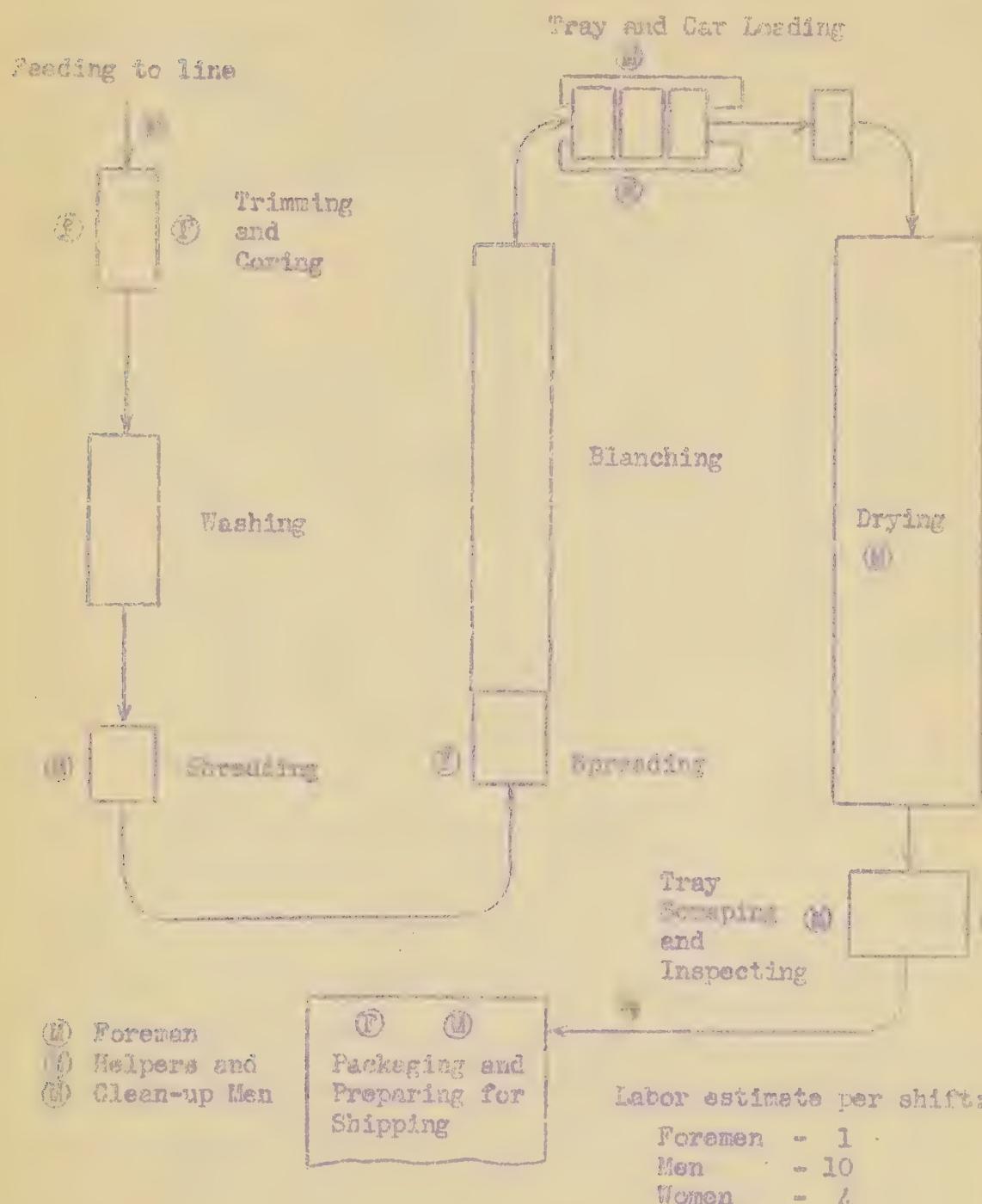
Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1918.

CANADA

DEHYDRATION PLANT OUTLINE

830 Pounds per Hour

Unprepared Basis



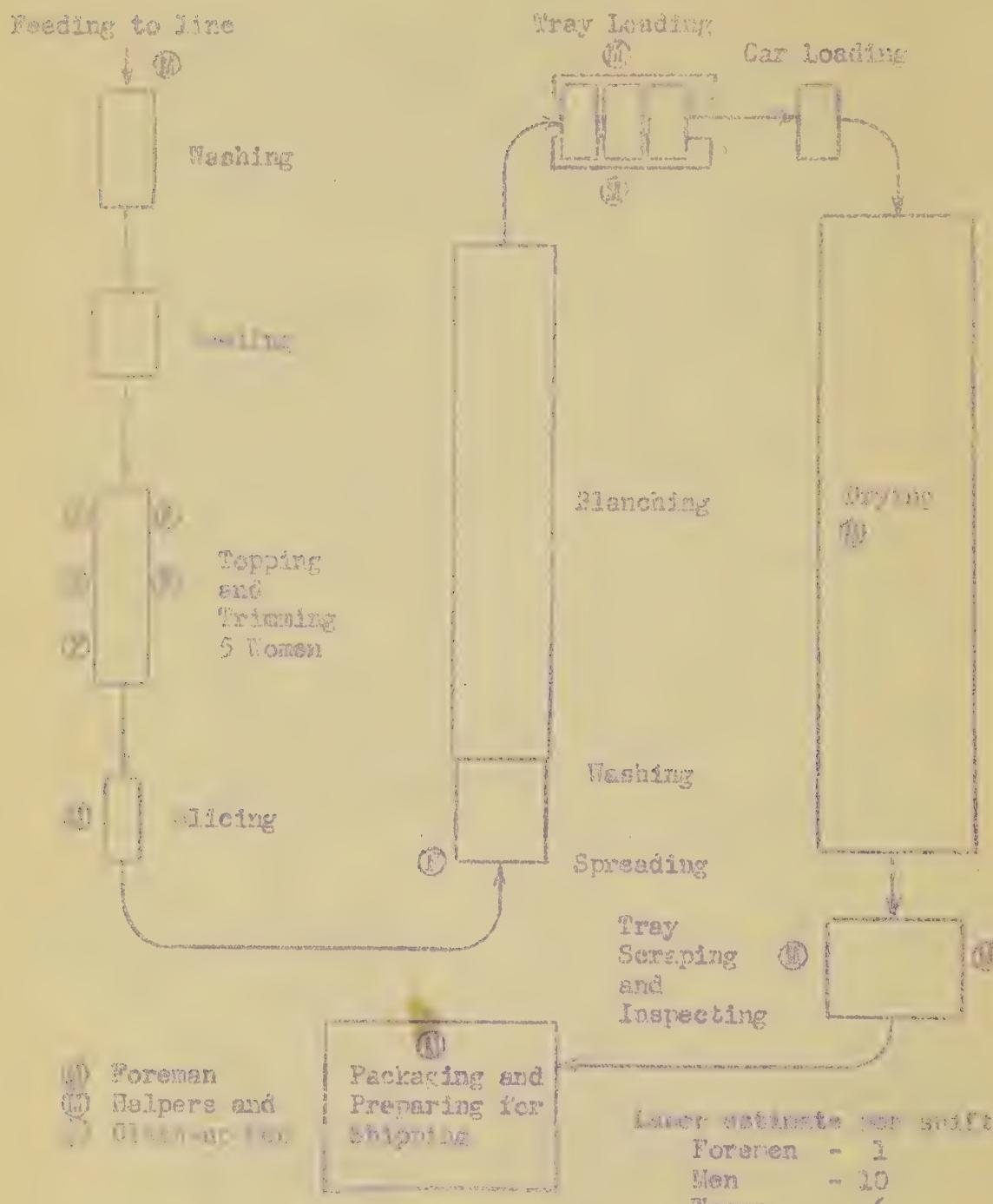
Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture

CARROTS

DEHYDRATION PLANT: SWEET

830 Pounds per Hour

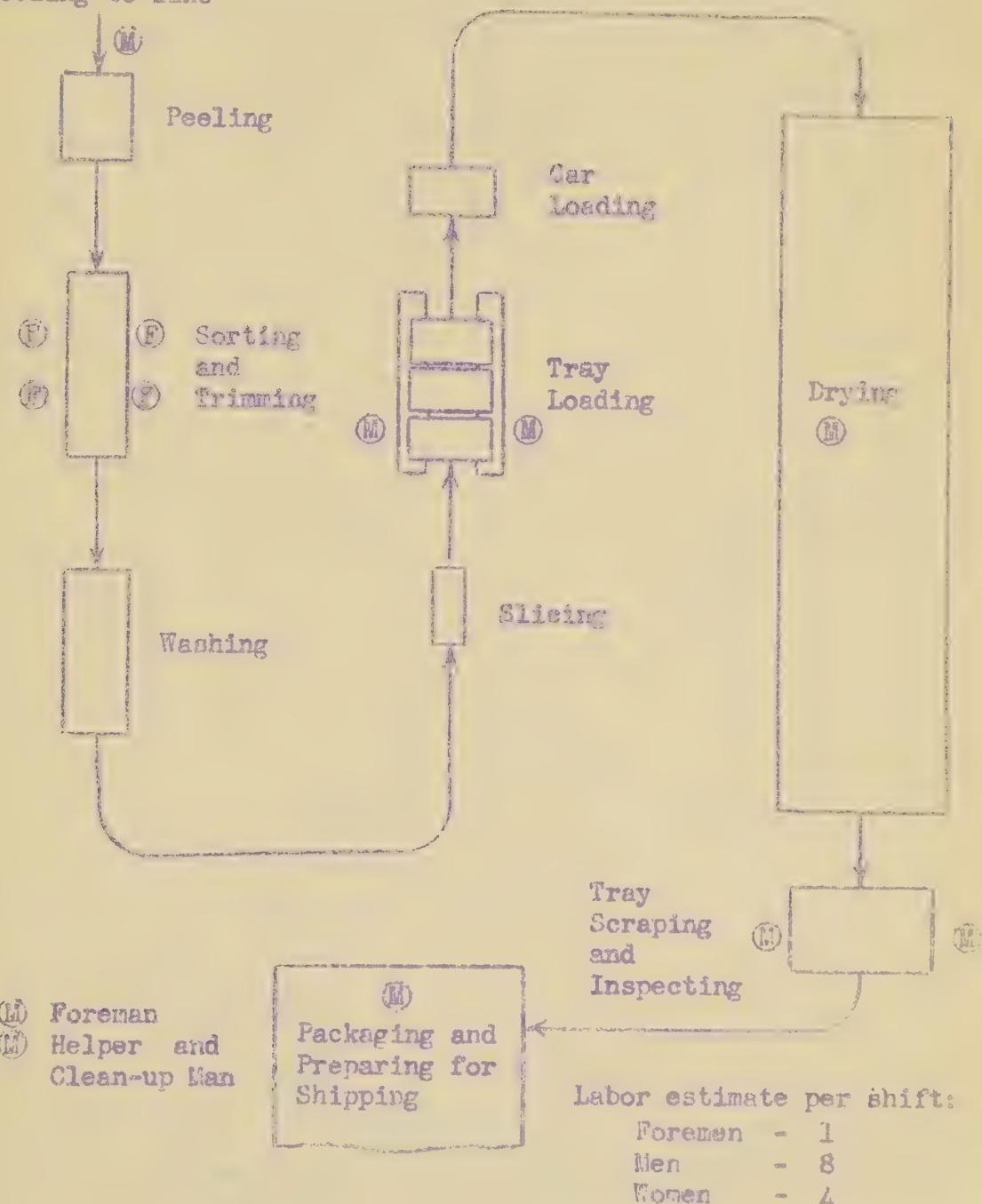
Unprepared Basis



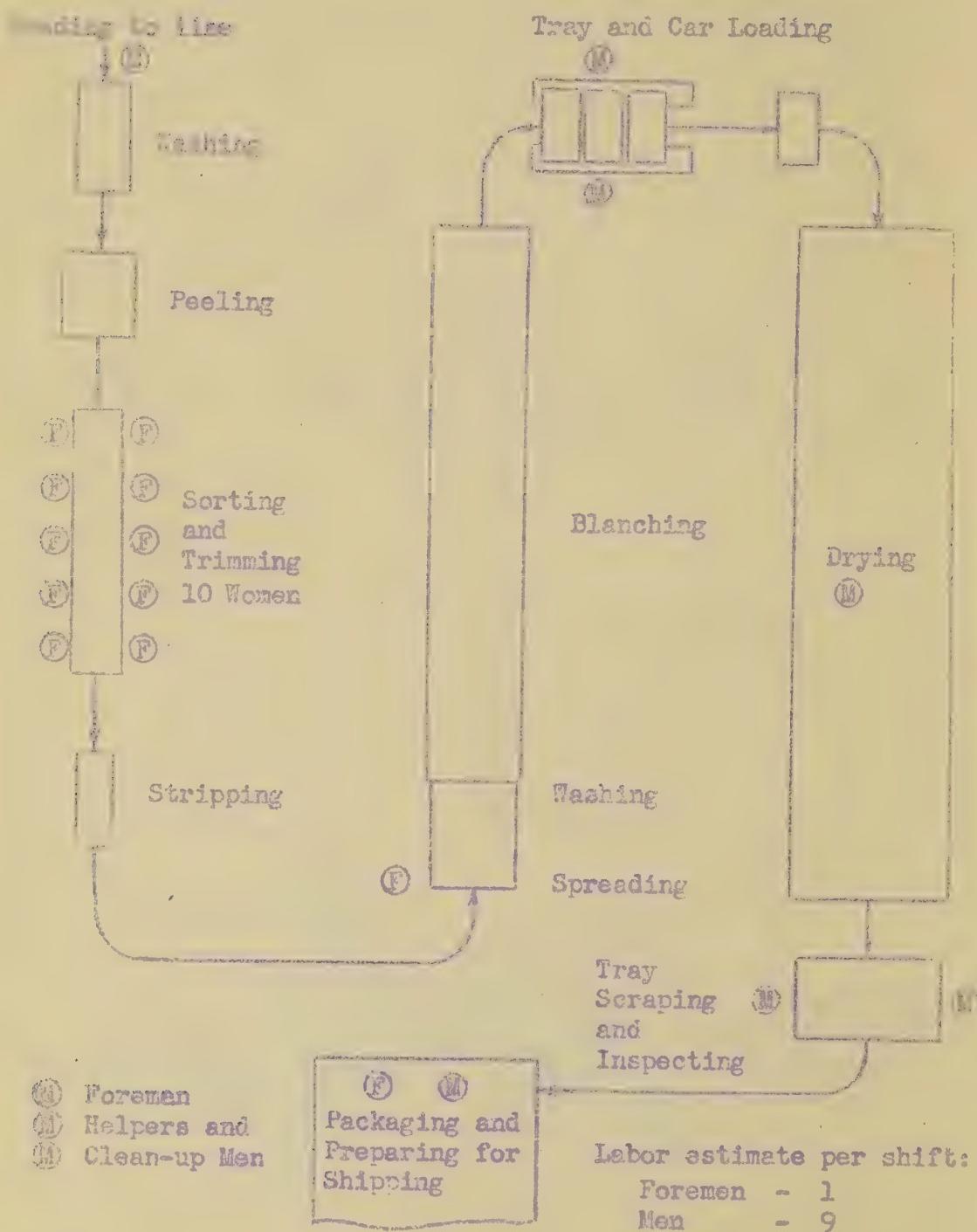
Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

ONIONS
DEHYDRATION FLOW SHEET
830 Pounds per Hour
Unprepared Basis

Feeding to line



POTATOES
DEHYDRATION FLOW SHEET
830 Pounds per Hour
Unprepared Basis



Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

LAWD BLESS YOU SISTER

850 Pounds per Hour

Unprepared Bass

Labor estimate per shift:

For women - 3

Men - 20

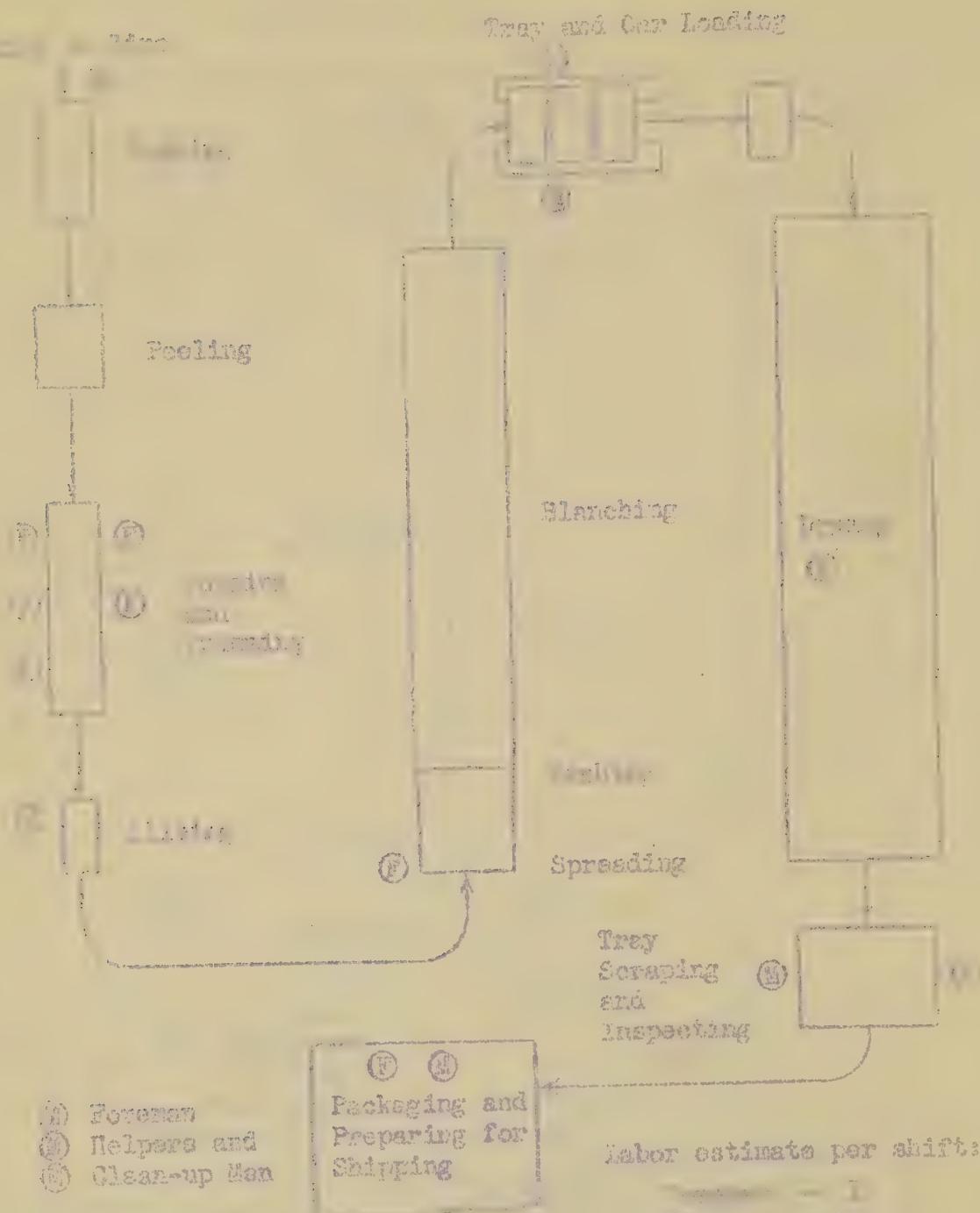
Women 47

Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

DEHYDRATION
DEMONSTRATION FLOOR PLAN

600 Pounds per Hour

Unprepared Basis



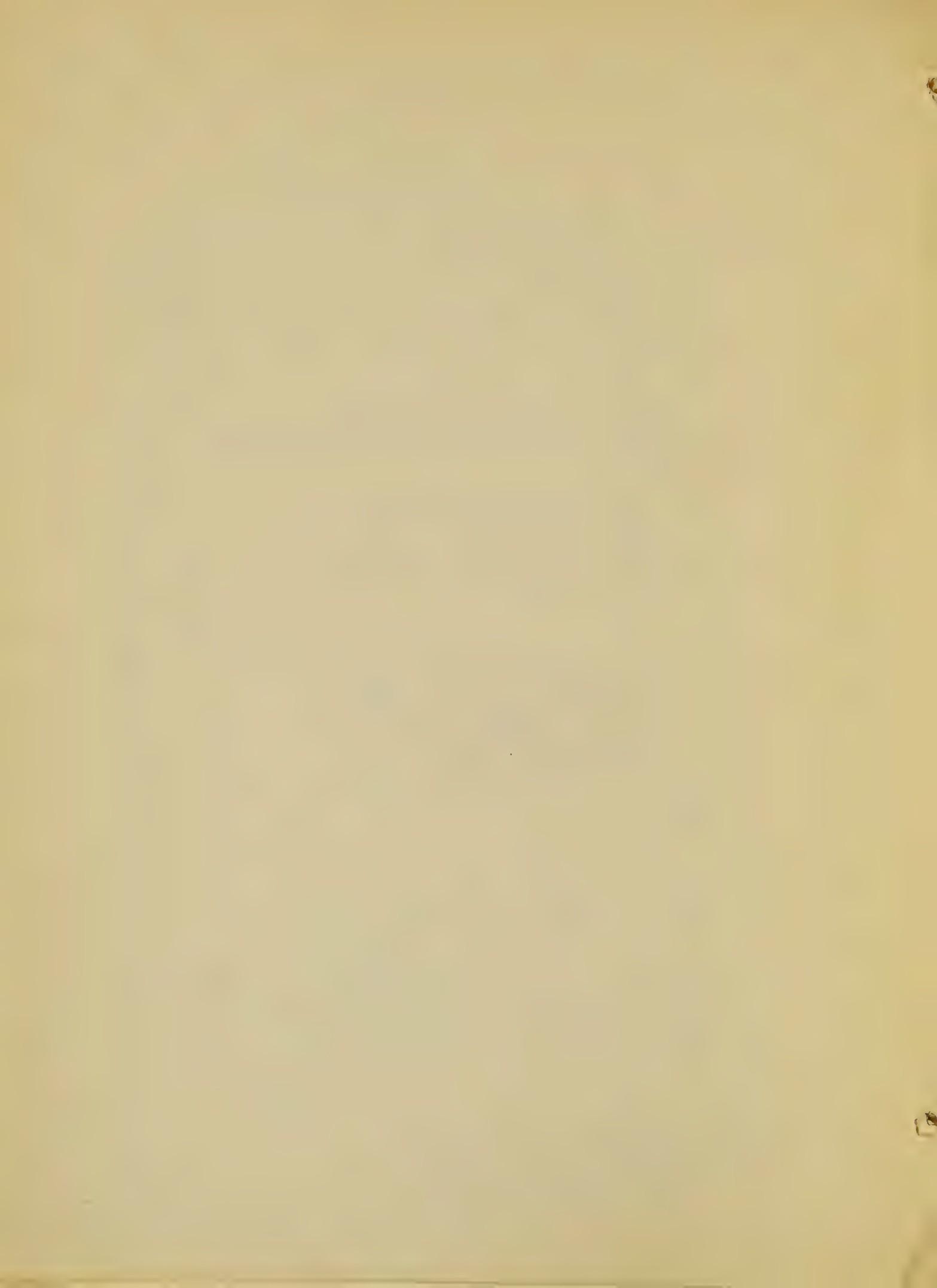
Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

or written communication to
Linton, inquiries should be addressed
to:

The Registration Committee
University of California, Berkeley
2400 Bancroft Way
Berkeley, California 94720
Telephone 415-643-1212

cc:

California Irrigation Commission
Division of Irrigation and Drainage
1000 K Street
Sacramento, California 95814
K. Richardson Street
Albany, California

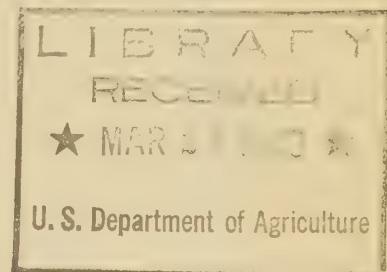


Bureau of Agricultural Costs, Supply and Marketing,
U. S. Department of Agriculture

ESTIMATES OF EQUIPMENT COSTS AND LABOR REQUIREMENTS

VEGETABLE DEHYDRATION

Plant Capacity--1,670 Pounds Per Hour
(Unprepared Basis)



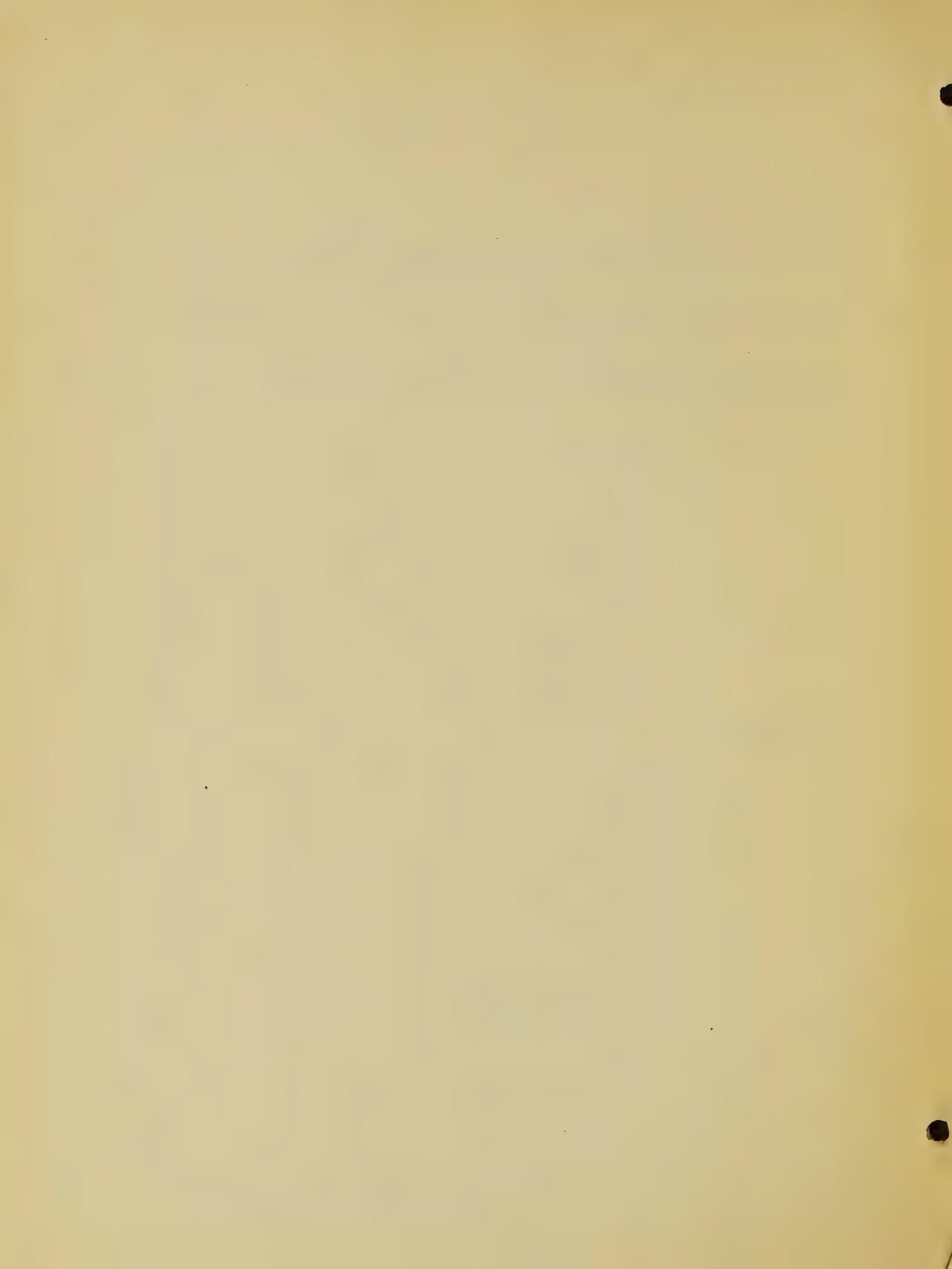
Preparation, final inspection and packaging equipment are the only types of equipment considered in this report. All labor requirements except clerical and shipping are included.

August 1942



TABLE OF CONTENTS

| | Page |
|--|------|
| GENERAL DISCUSSION..... | |
| SUMMARY OF EQUIPMENT AND LABOR COSTS..... | |
| (For seven vegetables important in dehydration) | |
| CAPACITIES PER UNIT OF TIME..... | 6 |
| (For seven vegetables important in dehydration) | |
| WASHING, FINAL INSPECTION, AND PACKAGING EQUIPMENT, AND LABOR REQUIREMENTS: | |
| Beets..... | 8 |
| Cabbage..... | 11 |
| Carrots..... | 13 |
| Onions..... | 15 |
| Potatoes..... | 16 |
| Sweet Potatoes (Yams)..... | 18 |
| Turnips (Rutabagas)..... | 20 |
| WASH SHEETS: | |
| Beets..... | 21 |
| Cabbage..... | 22 |
| Carrots..... | 24 |
| Onions..... | 25 |
| Potatoes..... | 26 |
| Sweet Potatoes (Yams)..... | 27 |
| Turnips (Rutabagas)..... | 28 |



Preparation, Final Inspection, and Packaging Equipment,
and Labor Requirements in
Vegetable Dehydrators at a Plant Capacity of 1,670 Pounds per Hour,
Unprepared Basis

This discussion deals with the labor requirements and cost of preparation and packaging equipment in dehydration plants capable of handling 1,670 pounds per hour, unprepared basis, or 20 tons per 24-hour day. The vegetables considered are:

| | | |
|-------------|----------|-----------------------|
| Table Beets | Carrots | Sweet Potatoes (Yams) |
| Cabbage | Onions | Turnips (Kutabagas) |
| | Potatoes | |

Ratio of equipment and labor for vegetable drying are subject to wide variation. The ability to invent certain items may permit substantial savings in plant investment as compared to a plant using standard cannery equipment. Proper plant layout may even eliminate some items. The balance between labor and machinery is a very important factor. The initial cost of a labor-saving machine may be large, but the labor cost saved may be much larger than capital and operating charges to the machine. Relative availability of labor and machinery may determine the proportion of labor and machine operation in a plant.

Equipment listed herein and indicated methods of operation are determined to be merely suggestive. Other types of equipment as well as other peeling procedures may be equally satisfactory or even better. For instance, mechanical abrasive peelers have been examined. Lye peeling, if permitted by purchase specifications, may be preferable on carrots, potatoes, and other hard root vegetables. Other peeling methods, for example, carbonization by flame or radiant heat, followed by vigorous scrubbing, have also shown promise on an experimental basis. Carrots, turnips and beets are shown as being peeled before topping. Under certain conditions it may be advisable to do the topping before peeling and the trimming after peeling. Standard abrasive peelers have not proven entirely satisfactory on onions. Operators have adopted various expedients to overcome this difficulty.

Costs and descriptions of equipment are based upon prices and information from established manufacturers in this field. The labor set-ups shown are based upon cannery operations and the operations of present commercial dehydrators. They will vary appreciably from plant to plant. If the items of equipment or sequence and methods of operations are different from those shown here, the labor set-up must be modified accordingly.

The accompanying tables show only major items of equipment needed in the preparation of vegetables for drying and in the final inspection

and packaging of the dry product. It is recognized that elevators and conveyors may be major items of cost. They have not been specifically included, except in a special case, because considerable improvising will usually be done by the plant operator in the utilization of these items of equipment or in the arrangement of other equipment so as to eliminate the necessity for their use. An allowance for installation and accessory equipment is intended for this purpose.

Peelers have the tendency to over-peel smaller size vegetables and inadequately peel larger ones. Hence, it is preferable to put only one size through the peeler at a time. This involves the use of a grader or sizer or the purchase of pre-graded vegetables. The latter might be particularly expedient in a small plant. A simple flat grader may be built at the plant at a cost which is only a small fraction of the cost of a commercially built grader.

Water spray at the beginning of the blancher belt is quite satisfactory in washing the diced, sliced, or stripped vegetables. A separate washer to do the same work may save several hundred dollars. Such a water spray at the front end of the blancher belt tends to prevent excessive humidity in the preparation room by condensing steam escaping from this end of the blancher.

The amount of steam necessary for blanching will vary from plant to plant depending upon losses from the blancher and cuts in the efficiency of steam usage. The range may be from 1 to 3 boiler horse-power hours per ton of unprepared vegetables cooked over 24-hour period. For carrots and sweet potatoes, a requirement of 2 boiler horsepower per ton per day has been assumed. Due to retort blanching requirements, a slightly larger amount is considered necessary. Sweet potatoes are scalded as well as blanched. Due to this double heating, they require somewhat more steam capacity. The plant designer can lessen the investment in steam boilers by insuring proper plant operation to minimize the steam losses and by operating the steam boiler above its rated capacity.

The line-up provides for little or no stand-by equipment. Where there is a possibility that the stopping of any machine will interrupt the continuous flow of the product through the plant, some means of substitute operation should be available or there should be storage facilities for the product so that it will not deteriorate while standing.

Allowance for waste disposal equipment has been made in these estimated costs. Since disposal of waste is a very important and expensive factor, it cannot be overlooked in setting up a plant. Each plant may have its own methods of waste disposal, but it is probable that in the case of potatoes and sweet potatoes

the most common method will involve carrying of wastes from the plant by water. This will necessitate a system of separating suspended solids from the water by screening, settling, or otherwise. These solids may be sold as easy, concentrated, or processed for byproduct values. The treated effluent may be run into a river, a running stream, or to a place of disposal. Other reasonable wastes may be hauled away, burned, or treated for byproduct recovery, but will usually involve a less serious sewage problem. Each of these methods will be subject to sanitary regulation. Due to the many factors involved, no attempt is being made at this time to show the cost of such equipment. A mechanical method of preparation, however, will usually require some ingenuity on the part of plant operators.

Initial cost of prepared vegetable has been considered. Preparation of vegetables in other forms will necessitate the installation of other types of cutters and will usually entail an increase in cost. The labor cost may also be affected to some extent by resulting differences in blancher loading, tray loading, and drying time.

In the case of onions, at least a portion of the product will usually be converted to a powder form. It is necessary to conduct this operation in a dry atmosphere and special equipment will have to be installed for this purpose. It is advantageous to conduct all onion packing operations in an air-conditioned room maintained at low humidity.

The cost of packaging equipment is listed on the assumed use of 5-galine cans. Recent practice has been to solder the top after filling the can with inert gas. A regulating valve for the gas, relatively inexpensive scales, and scales are the main items needed for this type of packaging. Other types of packaging which involve a larger capital investment, although the volume has been recently increased. Total cost per unit, external under the edge of the lid while eliminating the possibility for soldering. No increased capital investment is ordinarily involved in the use of the automatic can sealer since the machine is attached to the user. Equipment operating costs will be higher up to the initial paid, but these will be more than offset by lower labor costs.

Inspection belts included are straight single-unit belts. Merry-go-round or other divided belts will involve higher equipment costs on the scaling and trimming lines. Their use may, however, result in reduced labor costs.

The estimated net installation costs will amount to from 10 to 20% of the purchase price of the machinery. Valves, piping, wiring, trucks, boxes, scales, tools, and other accessory equipment plus some allowance for improvised items may amount to an additional 30 to 40%. Together these make a total of about 50% to be added to the purchase price to

cover the costs of installation and accessory items.

The number of employees needed to operate a plant is by no means fixed. Increased use of conveyors, chutes, elevators, and other automatic equipment will decrease the need for employees to handle the material.

When the prepared material on trays for drying and also in spreading the material on the blancher belt, it is necessary to spread it uniformly over the surface. This allows for proper air circulation and avoids areas which may not dry. In blanching, a uniform spray insures adequate penetration of heat to all pieces of the vegetable. In automatically loading the driers into spreading, all reduces the number of employees needed at these points.

The number of workers that are required on sorting and trimming tools will have a marked effect on the operation of the plant. As the number of trimmers, sorters, etc., will be spent on each product or other vegetables, this reduces waste and insures a higher dried product. Careful sorting and trimming will decrease the amount of dried material discarded in the trash, and prevent and decrease the likelihood of product rejections. There will however, be an optimum point for the cost economical operation of the plant in obtaining an acceptable product.

The material cost and labor cost per pound of dry product are directly and heavily influenced by preparation losses. A saving of even 5% in preparation losses (e.g. a decrease from 25% to 20% preparation loss) may justify the wages for a number of additional men per shift on the sorting and trimming tools. Improvement in the quality of the final product, no additional time in preparation and decrease in waste disposal cost are also secondary factors in determining whether an increase in the number of sorters and trimmers is warranted.

When the number of final inspectors needed is small, the operations of conveying and final inspection have been combined. This avoids the necessity of crowding a conveying belt or other means of passing the product before inspectors. The product can be inspected by the tray system, either on the tray before scraping or on a table top after scraping, the latter being essential when wooden trays are used.

It is assumed that the rates are shown on the accompanying charts will apply to the actual processing of the material, in care and operation of the equipment, and in removal of wastes from the plant.

The tables and charts assume continuous operation of the plant in three shifts, 8 hours. Since actual working time in a 8-hour shift may be only 7 hours, the indicated hourly capacities are only an average of quantities handled during the entire 8 hours. Quantities handled in any one hour of actual operation will have to be slightly higher if the assumed rate of production is to be maintained. The number of employees indicated should be sufficient to cover this difference.

SUMMARY OF COSTS

Preparation, Final Inspection and Packaging Equipment,
and Labor Requirements in
Vegetable Dehydration at a Plant Capacity of 1,670 Pounds per Hour

Unprepared Basis

| Name of Vegetable | Shrinkage | Equipment Cost | | | Labor Cost | | |
|-------------------|-----------|----------------|-------|-----------------------|------------|-----------|---------|
| | | Ratio | Total | Per Ton ^{1/} | | Per Pound | |
| | | | | Wet | Dry | (Unpre- | Dry |
| | | | | (Unpre- | (Unpre- | (Unpre- | (Unpre- |
| | | | | : | : | : | : |
| | | | | \$ | \$ | \$ | \$ |
| Potatoe | 13 to 1 | 7,350 | 368. | 4,778. | 1.17 | 15.3 | |
| Cabbage | 19 to 1 | 5,925 | 296. | 5,622 | 0.96 | 11.1 | |
| Carrots | 10 to 1 | 7,165 | 358. | 3,557. | 1.12 | 11.2 | |
| Onions | 14 to 1 | 4,765 | 238. | 3,235 | 0.96 | 12.9 | |
| Potatoes | 7 to 1 | 8,100 | 405. | 2,835 | 1.56 | 10.9 | |
| Sweet Potatoes | 4½ to 1 | 2,335 | 467. | 2,100. | 1.23 | 5.5 | |
| Turnips | 10 to 1 | 7,315 | 366. | 3,655 | 1.16 | 11.6 | |

^{1/} Equipment cost per ton handled per 24-hour day.

Capacities per Unit of Time
In a Vegetable Dehydration Plant
Capable of Handling 1,670 Pounds per Hour

(Unprepared Basis)

| Form Prepared | | | | | | Sweet |
|--|--------|---------|---------|--------|----------|----------------------|
| | Beets | Cabbage | Carrots | Onions | Potatoes | Potatoes T (Yams) |
| | Slices | Shreds | Slices | Slices | Strips | Slices |
| <u>Unprepared basis:</u> | | | | | | |
| Tons per 24-hour day | 20 | 20 | 20 | 20 | 20 | 20 |
| Pounds per 24-hour day | 40,000 | 40,000 | 40,000 | 40,000 | 40,000 | 40,000 |
| Pounds per hour | 1,670 | 1,670 | 1,670 | 1,670 | 1,670 | 1,670 |
| Pounds per minute | 28 | 28 | 28 | 28 | 28 | 28 |
| Number of women coring | | 3 | | | | |
| Pounds per woman per hour | | 555 | | | | |
| Pounds per woman per minute | | 9.3 | | | | |
| Number of retorts | 1 | | | | | |
| Blanching time in minutes | 10 | | | | | |
| Minutes per charge per retort - | | | | | | |
| Loading, blanching & unloading | 20 | | | | | |
| Chargees per hour | 3 | | | | | |
| Pounds per charge | 560 | | | | | |
| Cars or crates per charge | 1 | | | | | |
| Cards per car or crate | 560 | | | | | |
| Trays per car | 5 | | | | | |
| Pounds per tray | 112 | | | | | |
| <u>Prepared basis:</u> | | | | | | |
| Assumed preparation loss | 30% | 25% | 25% | 15% | 25% | |
| Tons per 24-hour day | 14 | 15 | 15 | 17 | 15 | |
| Pounds per 24-hour day | 28,000 | 30,000 | 30,000 | 34,000 | 30,000 | |
| Pounds per hour | 1,170 | 1,250 | 1,250 | 1,420 | 1,250 | |
| Pounds per minute | 20 | 21 | 21 | 24 | 21 | |
| Number of women sorting, tipping & trimming | 10 | | 10 | 8 | 20 | |
| Pounds per woman per hour | 115 | | 125 | 180 | 65 | |
| Pounds per woman per minute | 2.0 | | 2.1 | 3.0 | 1.0 | |
| <u>Assumed blancher loading -</u> | | | | | | |
| Ibs. per square foot | 1.5 | 2.0 | | | 2.0 | |
| Assumed blanching time in minutes | 5 | 4 | | | 4 | |
| Pounds in blancher at any one time | 63 | 83 | | | 83 | |
| Square feet of blancher needed | 42 | 42 | | | 42 | |
| <u>Assumed tray loading -</u> | | | | | | |
| Ibs. per square foot | 1.5 | 1.2 | 1.5 | 1.2 | 1.5 | |
| Pounds per car | 590 | 475 | 590 | 475 | 590 | |

9

Capacities per Unit of time
In a Vegetable Dehydration Plant
Capable of Handling 1,670 Pounds per Hour (cont'd)

(Unprepared Basis)

| <u>Time Required</u> | Sweet | | | | | | |
|--|--------|---------|---------|--------|----------|-----------------|--------|
| | Beets | Cabbage | Carrots | Onions | Potatoes | Potatoe Turnips | (Yams) |
| Slices | Shreds | Slices | Slices | Strips | Slices | Slices | Slices |
| Cars per 24-hour day | 47 | 63 | 51 | 72 | 51 | 51 | 54 |
| Cars per hour | 2.0 | 2.6 | 2.1 | 3.0 | 2.1 | 2.1 | 2.2 |
| Minutes per car | 30 | 23 | 29 | 20 | 29 | 29 | 27 |
| Trays per car | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| Pounds per tray | 27 | 21.6 | 27 | 21.6 | 27 | 27 | 27 |
| Trays per 24-hour day | 1,040 | 1,390 | 1,110 | 1,570 | 1,110 | 1,110 | 1,190 |
| Trays per hour | 43 | 58 | 46 | 65 | 46 | 46 | 50 |
| Trays per minute | 0.72 | 0.97 | 0.77 | 1.1 | 0.77 | 0.77 | 0.83 |
| Seconds per tray | 85 | 60 | 80 | 55 | 80 | 80 | 70 |
| <u>Dried Basis</u> | | | | | | | |
| Overall shrinkage ratio 13 to 1 19 to 1 10 to 1 14 to 1 7 to 1 14 to 1 10 to 1 | | | | | | | |
| Cans per 24-hour day | 3,080 | 2,147 | 4,000 | 2,860 | 3,710 | 3,890 | 4,000 |
| Pounds per hour | 130 | 90 | 165 | 120 | 240 | 370 | 165 |
| Pounds per minute | 2.1 | 1.5 | 2.8 | 2.0 | 4.0 | 6.2 | 2.8 |
| Pounds per 5-gallon can | 10 | 5 | 14 | 9 | 10 | 13 | 6 |
| Cans per 24-hour day | 310 | 420 | 285 | 320 | 570 | 685 | 665 |
| Cans per hour | 13 | 18 | 12 | 13 | 24 | 29 | 28 |
| Minutes per can | 4.6 | 3.3 | 5.0 | 4.6 | 2.5 | 2.1 | 2.1 |

TABLE BEETS

Preparation, Firing, Drying and Cooling, and Shipping
Labor Requirements

In a Dehydration Plant Capable of Handling 1,670 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> <u>Description of Equipment</u> | <u>Labor</u> <u>Cost</u> |
|--|--|-----------------------------|
| Feeding to Preparation Line | | 1 M |
| Washing | Rotary bar washer Drum size - 25" x 8½" With 1½ h.p. motor | \$ 600. |
| Blanching - 10 minutes at 5 pounds pressure in retorts | Horizontal retort - 2 car capacity Cylinder - 54" x 7½" 20 trays and 4 retort cars | 1,050. 2 M 175. |
| Peeling | Continuous peeler With 3 h.p. motor | 1,100. |
| Capping and Trimming | Belt conveying sorter Belt size - 30" x 15' With 1 h.p. motor | 10 F 800. |
| Washing | Washer elevator with water boot Draper width - 18" With $\frac{1}{2}$ h.p. motor | 400. |
| Slicing | Slicer with $\frac{1}{2}$ h.p. motor | 475. |
| Loading and Stacking | Rollers, scales and other loading equipment are small items. These are included in cost of accessory equipment. See below | 2 F 2 M |
| Moving Cars and Drying | | 1 M |
| Scraping Trays | Table tops over bins | 200. 4 M |
| Final Inspecting | Inspection done by employees scraping trays. | |
| Packaging and Preparing for Shipping | Scales, table and sealing equipment | 1 F 100. 1 M |

TABLE BPETS (continued)

| <u>Operation</u> | <u>Equipment</u> | <u>Description of Equipment</u> | <u>Cost</u> |
|--|---|---------------------------------|-------------|
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | | |
| | Sub-total | | \$4,900. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | 50% | | \$24,500. |
| | Total | | \$7,350. |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | | \$ 365. |
| Labor Cost per Pound - (13 to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 13 Women \$60¢ per hour 14 Men 75¢ " " " 1 Foreman 1.25 | \$ 7.80 10.50 1.25 | \$ 11.50 |
| | Labor cost per wet pound (1,670 lbs) | | 1.17 |
| | Labor cost per dry pound (128 lbs) | | 15.3 |
| Steam Generating - Approximate Boiler Horsepower Needed - (2½ b.h.p. per ton per day) For blanching only. Approximate Cost of Boiler if operated at Rated Capacity | 50 b.h.p. | | \$4,000. |

CABBAGE
 Preparation, Final Inspection and Packaging Equipment, and
 Labor Requirements
 In a Dehydration Plant Capable of Handling 1,670 Pounds per Hour

Unprepared Basis

Operation

Equipment

Description of Equipment

Cost

Labor

feeding to Preparation Line

Equipment for feeding to the line will probably have to be improvised for this size plant \$1,000.

Trimming and Coring

Table - 3' x 10'

3 Improvised cabbage corers
With $\frac{1}{2}$ h.p. motor
located over table

75.

3 F

Rotary bar washer

Drum size - 25" x 8 $\frac{1}{2}$ "
With 1 $\frac{1}{2}$ h.p. motor

600.

Kraut cutter

20" disc
With 1 h.p. motor

325.

1 M

Spreading on Blancher Belt

Blanching, 3 minutes - Loading on blancher belt, 1 $\frac{1}{2}$ pounds per square foot.

Wire belt blancher

Overall length - 25'
Covered area - 30" x 17"
With 1 $\frac{1}{2}$ h.p. motor

1,500.

Tray Loading and Stacking

Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below

2

2

Moving Cars and Drying

Scraping Trays

Table tops over bias

200.

Final Inspecting

Inspection done by employees scraping trays.

Packaging and Preparing for Shipping

Scales, table, and sealing equipment

100.

8

4

- 1 -

CABBAGE (continued)

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|---|---|----------------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| General - Foreman | | 1 M |
| Helpers, cleanup, washing trays, and maintenance | | 3 M |
| Sub-total | | \$3,950. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | 50% | <u>1,975.</u> |
| Total | | <u>\$5,925</u> |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | \$ 296 |
| | 7 Women @ 60¢ per hour | \$ 4.20 |
| Labor Cost per Pound - (19 to 1 overall shrinkage ratio) | 14 Men @ 75¢ " " | 10.50 |
| (Based on the labor cost per hour) | 1 Foreman | <u>1.25</u> \$ 15.95 |
| | Labor cost per wet pound (1,670 lbs) | 0.96¢ |
| | Labor cost per dry pound (88 lbs) | 18.1 ¢ |
| Steam Generating - Approximate | | |
| Boiler Horsepower Needed (2 b.h.p. per ton per day) For blanching only. | | 40 b.h.p. |
| Approximate Cost of Boiler if Operated at Rated Capacity | | \$3,400.. |

LA 303

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements

An Inspection Plant Capable of Handling 1,670 Pounds per Hour

Unprepared Basis

| <u>Operations</u> | <u>Equipment</u> <u>Description of Equipment</u> | <u>Cost</u> | <u>Labor</u> |
|--|---|-------------|--------------|
| Feeding to Preparation Line | | | 1 M |
| Washing | Rotary bar washer Drum size - 25" x 8½" With 1½ h.p. motor | \$ 600. | |
| | Continuous peeler With 3 h.p. motor | 1,200. | |
| Cutting and Trimming | Belt conveying sorter Belt size - 30" x 15" With 1 h.p. motor | 800. | 10 F |
| Slicing | Slicer With ½ h.p. motor | 475. | 2 F |
| Spreading on Blancher Belt | | | |
| Washing | Sprays on front end of blancher. Included in blancher cost. | | |
| Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 25' Covered area - 30" x 17" With 1½ h.p. motor | 1,500. | |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | | 2 F 2 M |
| Moving Cars and Drying | | | 1 M |
| Scraping Trays | Table tops over bins | 200. | 4 M |
| Final Inspecting | Inspection done by employees scraping trays. | | |
| Packaging and Preparing for shipping | Scales, table, and sealing equipment | 100. | 1 F 1 M |

OAK CREEK (continued)

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|--|---|--------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| General - Foreman Helpers, cleanup, tray washing, and maintenance. | | |
| Sub-total | | \$4,775. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | | 50% |
| Total | | |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | |
| Labor Cost per Pound - (10 to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 14 Women @ 60¢ per hour \$8.40 12 Men " 75¢ " " 9.00 1 Foreman 1.25 | \$ 19.65 |
| | Labor cost per wet pound (1,670 lbs) | 1.125 |
| | Labor cost per dry pound (167 lbs) | 1.125 |
| Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blanching only. Approximate Cost of Boiler if Operated at Rated Capacity | | 40 b.h.p. |

CNIONS

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements
In a Dehydration Plant Capable of Handling 1,670 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|---|---|--------------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| Freezing to Preparation Line | | 1 M |
| Peeling | Continuous peeler With 3 h.p. motor | \$1,100. |
| Sorting and Trimming | Belt conveying sorter Belt size - 30" x 12' With 1 h.p. motor | 8 F 700. |
| Washing | Rotary bar washer Drum size - 25" x 8½' With 1½ h.p. motor | 600. |
| Slicing | Slicer With $\frac{1}{2}$ h.p. motor | 475. |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below | 2 F 2 M |
| Moving Cars and Drying | | 1 M |
| Scraping Trays | Table tops over bins | 200. 4 M |
| Final Inspecting | Inspection done by employees scrapping trays. | |
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | 3 F 1 M 100. |
| General - Foremen Helpers, cleanup, washing trays, and maintenance. | | 1 M 2 M |
| Sub-total | | \$3,175 |
| All 40% for installation and accessory equipment; 50% for same plus improvised items. | 50% | <u>1,590.</u> |
| Total | | <u>\$4,765.</u> |

ONIONS (continued)

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|--|--|----------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| Equipment Cost per Ton Handled per 24-Hour Day (Unprepared Basis) | | <u>\$ 238.</u> |
| Labor Cost per Pound - (14 to 1 overall shrinkage) | 11 Women @ 60¢ per hour \$ 6.60 11 Men @ 75¢ " " 8.25 1 Foreman 1.25 | 16.10 |
| (Based on the labor cost per hour) Labor cost per wet pound (1,670 lbs) | | 0.96 |
| Labor cost per dry pound (119 lbs) | | 13.5 |

POTATOES

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements
in a Dehydration Plant Capable of Handling 1,670 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|--|---|--------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| Feeding to Preparation Line | | 1 M |
| Washing | Rotary bar washer Drum size - 25" x 8½" With 1½ h.p. motor | \$ 600. |
| Sizing | Improvised wood-slat sizer | 50. |
| Peeling | Continuous peeler With 3 h.p. motor | 1,100. |
| Sorting and Trimming | Belt conveying sorter Belt size - 30" x 30' With 2 h.p. motor | 1,150. |
| | Strip cutter and slicer With 2 h.p. motor | 700. |
| Spreading on Blancher Belt | | 1 F |
| Washing | Sprays on front end of blancher - Included in blancher cost. | |
| Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 25' Covered area - 30" x 17" With 1½ h.p. motor | 1,500. |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | 2 F 2 M |
| Moving Cars and Drying | | 1 M |
| Scraping Trays | Table tops over bins | 200. |
| Final Inspecting | Inspection done by employees scraping trays. | |

POTATOES (continued)

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|--|--|--------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | \$ 100. 2 |
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | |
| Sub-total | | \$5,400. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items | 50% | 2,700. |
| Total | | |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | |
| Labor Cost per Pound - (7 to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 24 Women @ 60¢ per hour \$14.40 14 Men @ 75¢ " " 10.50 1 Foreman 1.25 Labor cost per wet pound (1,670 lbs) | 1.00 |
| | Labor cost per dry pound (240 lbs) | 10.00 |
| Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blanching only. Approximate Cost of Boiler if Operated at Rated Capacity | 40 b.h.p. | |

SWEET POTATOES

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements

In a Dehydration Plant Capable of Handling 1,670 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> <u>Description of Equipment</u> | <u>Cost</u> | <u>Labor</u> |
|--|--|-------------|--------------|
| Feeding to Preparation Line | | | 1 M |
| Cashing | Rotary bar washer Drum size - 25" x 8½" With 1½ h.p. motor | \$ 600. | |
| Boiling, 10 Minutes in Boiling Water | Continuous hot water scalding Tank - 24" x 10" With 1½ h.p. motor | 1,100. | |
| Peeling | Continuous peeler With 3 h.p. motor | 1,100. | |
| Cutting and Trimming | Belt conveying sorter Belt size - 30" x 18" With 1 h.p. motor | 850. | 12 F |
| Blanching | Slicer With $\frac{1}{2}$ h.p. motor | 475. | |
| Spreading on Blancher Belt | | | 1 F |
| Cooking | Sprays on front end of blancher - Included in blancher cost. | | |
| Blanching, 6 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 34' Covered area - 30" x 25' With 1½ h.p. motor | 1,800. | |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items, being included as accessory equipment. | | 2 P 2 M |
| Cooling Cars and Drying | | | 1 M |
| Scraping Trays | Table tops over bins | 200. | 4 M |
| Final Inspecting | Inspection done by employees scraping trays. | | |

STANDARD COSTS (continued)

| Operation | Equipment | | Cost |
|---|---|-----|-------------------------------|
| | Description of Equipment | | |
| Packaging and Preparing for | Scales, table, and sealing equipment | | \$ 100. |
| General - Foreman | | | 1 |
| Helpers, cleanup, washing trays, and maintenance | | | 3 |
| Sub-total | | | \$6,225. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | | 50% | <u>\$3,110.</u> |
| Total | | | <u>\$2,335.</u> |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | | <u>\$2,467</u> |
| Labor Cost per Pound - (4½ to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 16 Women \$60¢ per hour 13 Men 375¢ " " 1 Ton | | \$ 9.60 9.75 <u>1.2</u> |
| | Labor cost per wet pound (1,670 lbs) | | 3 |
| | Labor cost per dry pound (370 lbs) | | 5 |
| Steam Generating - Approximate Boiler Horsepower Needed - (3 b.h.p. per ton per day) For blanching and sealing only | | | 60 b.h.p. |
| Approximate Cost of Boiler if Operated at Rated Capacity | | | \$4,400. |

TURNIPS

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements

In a Dehydration Plant Capable of Handling 1,670 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> | <u>Cost</u> |
|--|---|-------------|
| | <u>Description of Equipment</u> | |
| Feeding to Preparation Line | | |
| | Rotary bar washer Drum size - 25" x 8 $\frac{1}{2}$ " With 1 $\frac{1}{2}$ h.p. motor | \$ 600. |
| | Continuous peeler With 3 h.p. motor | 1,100. |
| Blanching and Trimming | Belt conveying sorter Belt size - 30" x 15" With 1 h.p. motor | 800. |
| Slicing | Slicer With $\frac{1}{2}$ h.p. motor | 475. |
| Spreading on Blancher Belt | | 1 F |
| Washing | Sprays on front end of blancher - Included in blancher cost. | |
| Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 26' Covered area - 30" x 18" With 1 $\frac{1}{2}$ h.p. motor | 1,600. |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | |
| Moving Cars and Drying | | 1 F |
| Scraping Trays | Table tops over bins | 200. |
| Final Inspecting | Inspection done by employees scraping trays. | |

TURNIPS (continued)

| <u>Operation</u> | <u>Equipment</u> <u>Description of Equipment</u> | <u>Labor</u> <u>Cost</u> |
|--|---|-------------------------------------|
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | 1 F 2 H 100. |
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | 1 M 3 M |
| | Sub-total | \$4,875. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | | 50% 2,440. |
| | Total | <u>\$7,315.</u> |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | \$ 366. |
| Labor Cost per Pound - (10 to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 14 Women @ 60¢ per hour \$8.40 13 Men @ 75¢ " " 9.75 1 Foreman 1.25 Labor cost per wet pound (1,670 lbs) Labor cost per dry pound (167 lbs) | 19.40 1.16¢ 11.6 ¢ |
| Steam Generating - Approximate Boiler Horsepower needed - (2 b.h.p. per ton per day) For blanching only. | 40 b.h.p. | |
| Approximate Cost of Boiler if Operated at Rated Capacity | | \$3,400. |

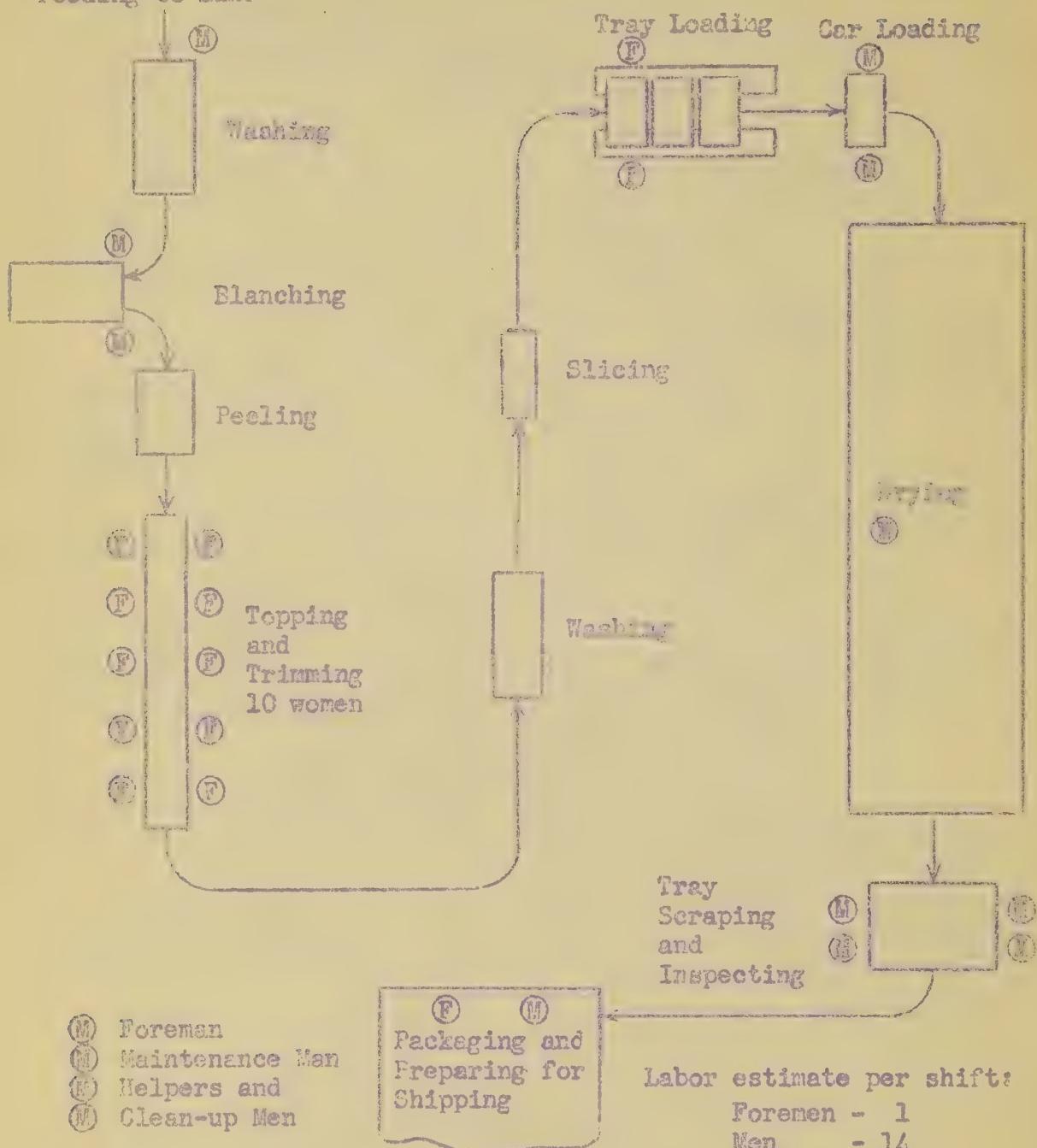
BEETS

DEHYDRATION FLOW SHEET

1670 Pounds per Hour

Unprepared Basis

Feeding to line



- (M) Foreman
- (M) Maintenance Man
- (M) Helpers and Clean-up Men

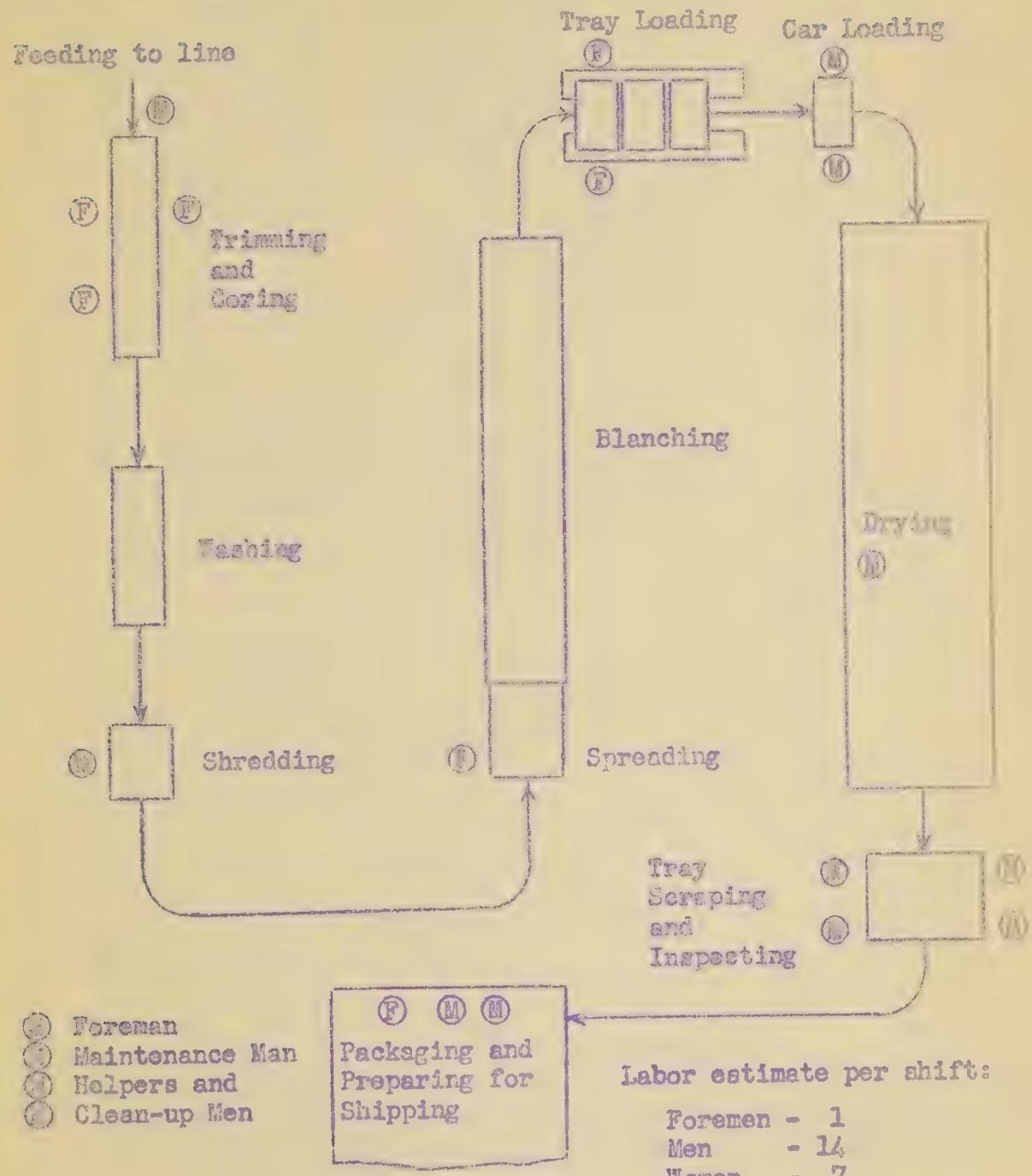
(F) (M)
Packaging and
Preparing for
Shipping

Labor estimate per shift:
Foremen - 1
Men - 14
Women - 13

DEHYDRATION PLOT SHEET

1670 Pounds per Hour

Unprepared Basis



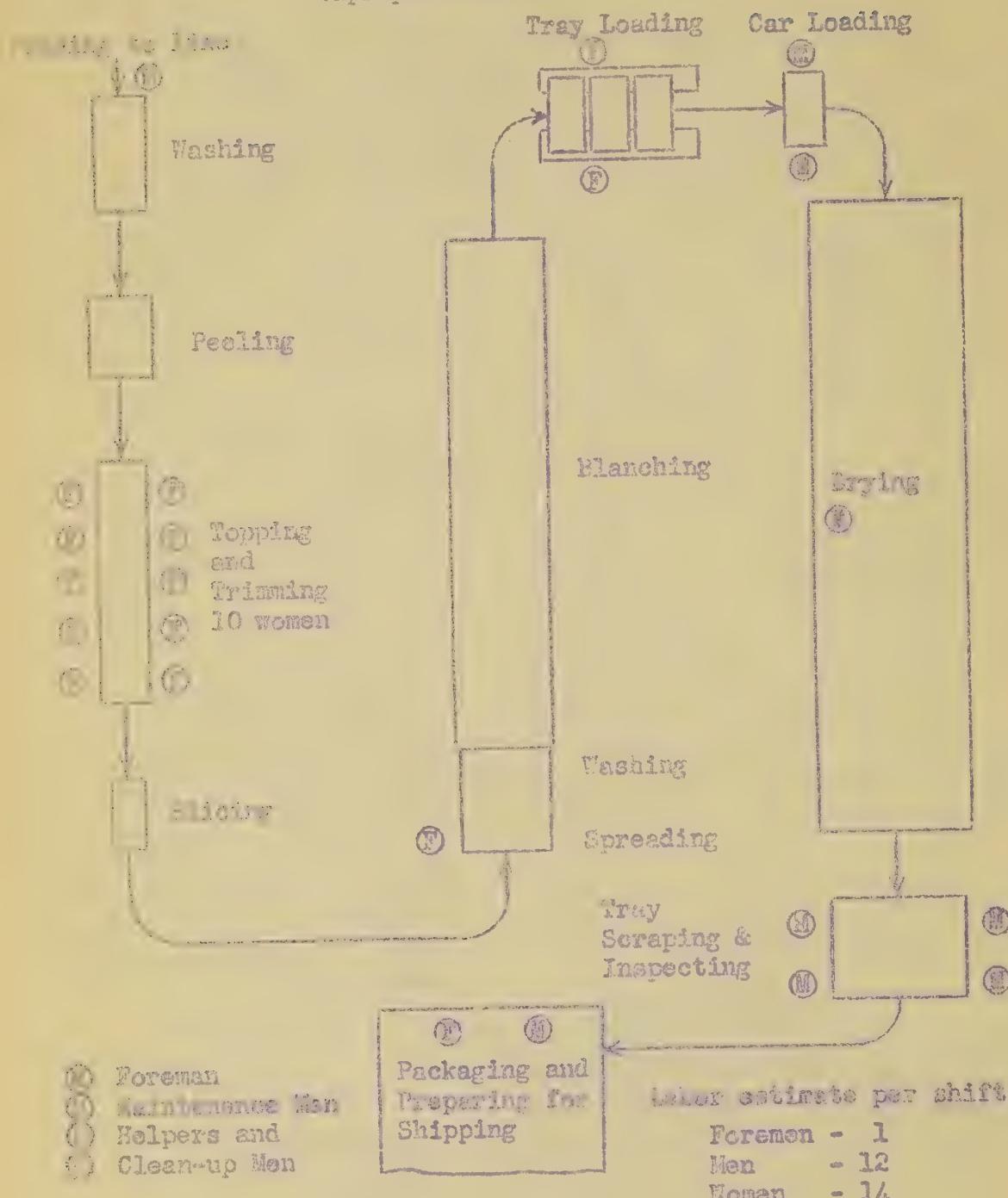
Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

CARROTS

DEHYDRATION FLOW SHEET

1670 Pounds per Hour

Unprepared Basis



- (1) Foreman
- (2) Maintenance Man
- (3) Helpers and
- (4) Clean-up Men

Labor estimate per shift:
Foremen - 1
Men - 12
Women - 14

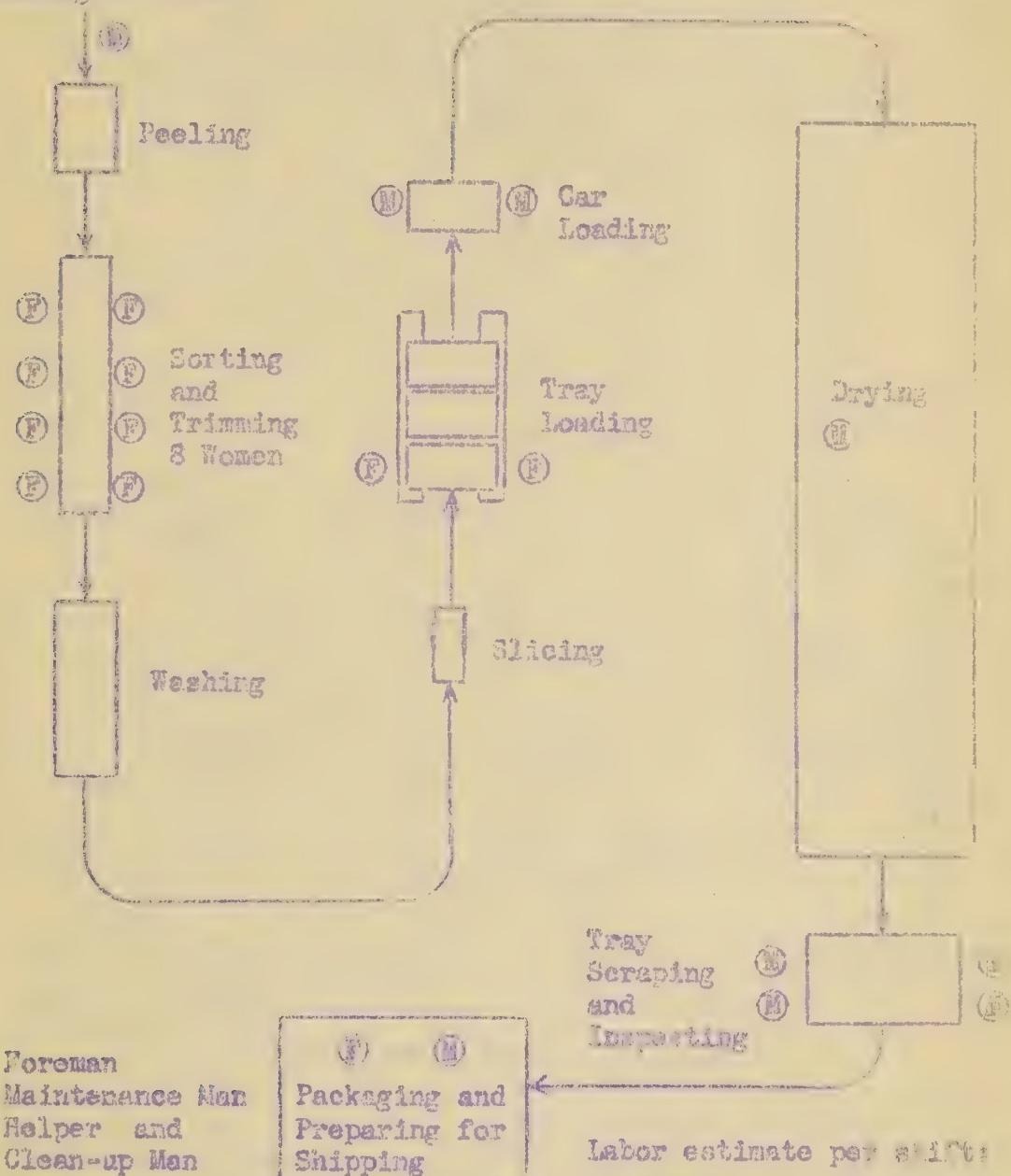
Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture. August 1918.

DEHYDRATION FLOW SHEET

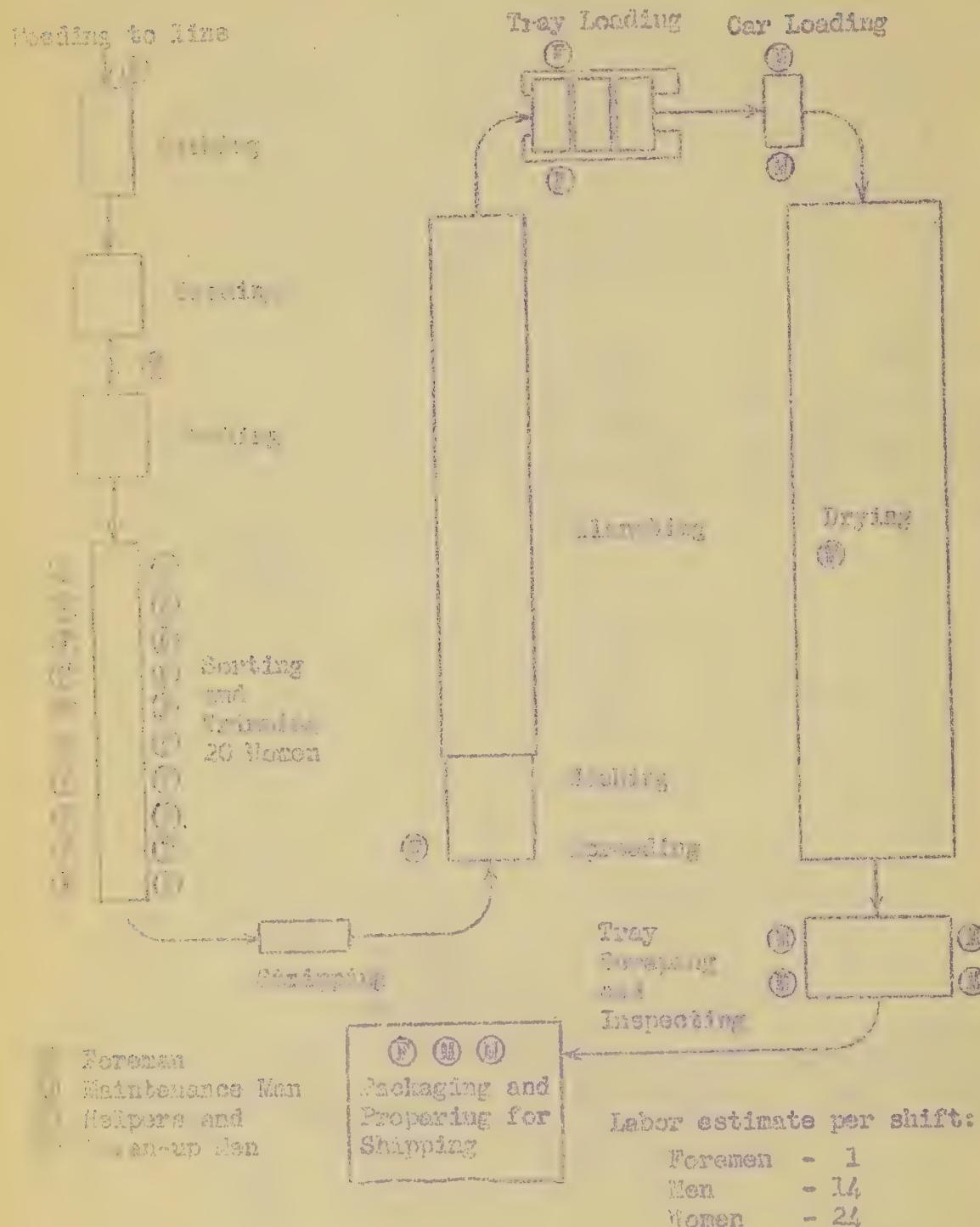
1670 Pounds per Hour

Unprepared Basis

Feeding to line



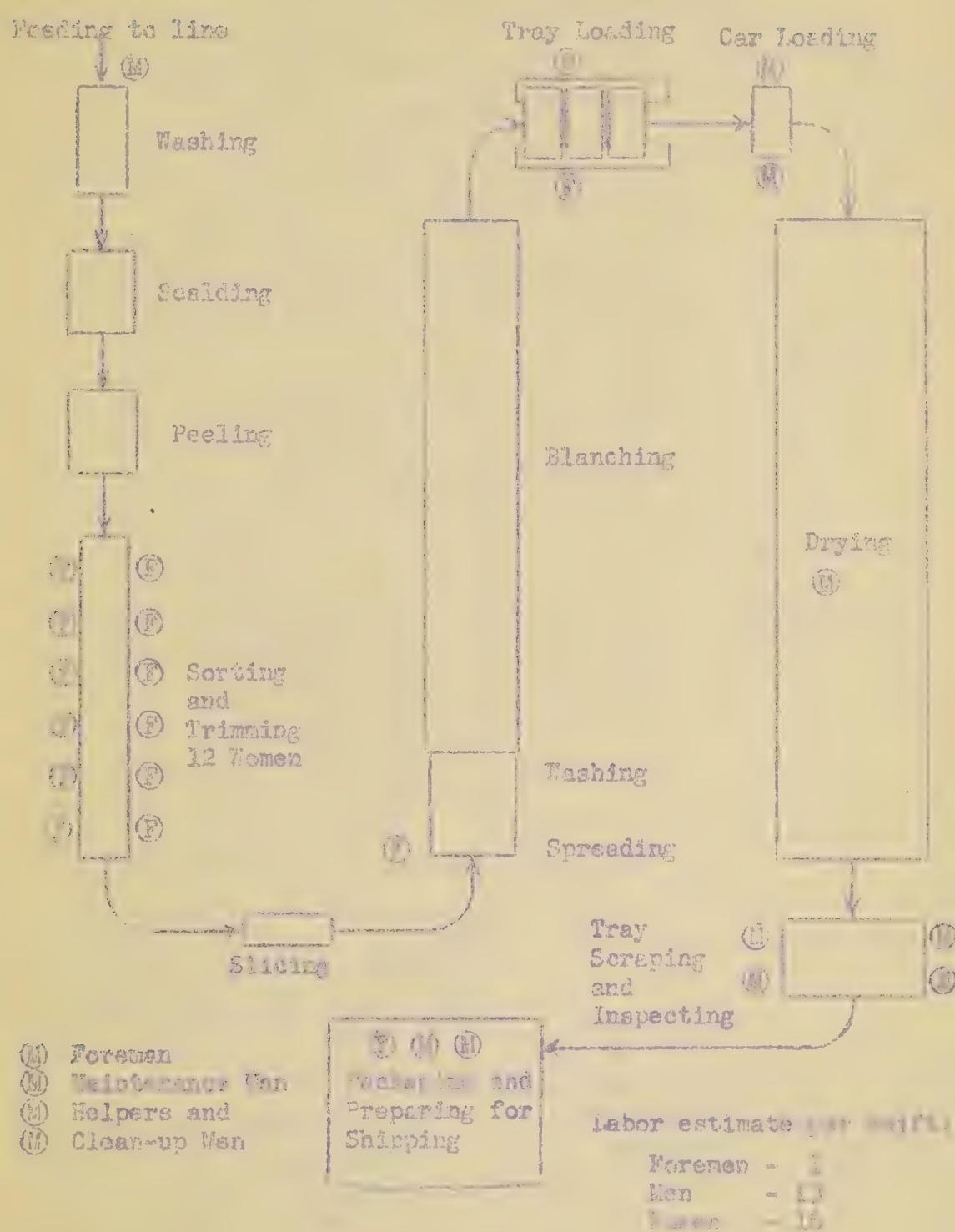
POTATOES
DEHYDRATION FLOW SHEET
1670 Pounds per Hour
Unprepared Basis



Prepared by the Dehydration Committee,
Year of Agricultural Chemistry and
United States Department of
Agriculture, Washington, D. C.

1670 Pounds per Hour

Unprepared Basis

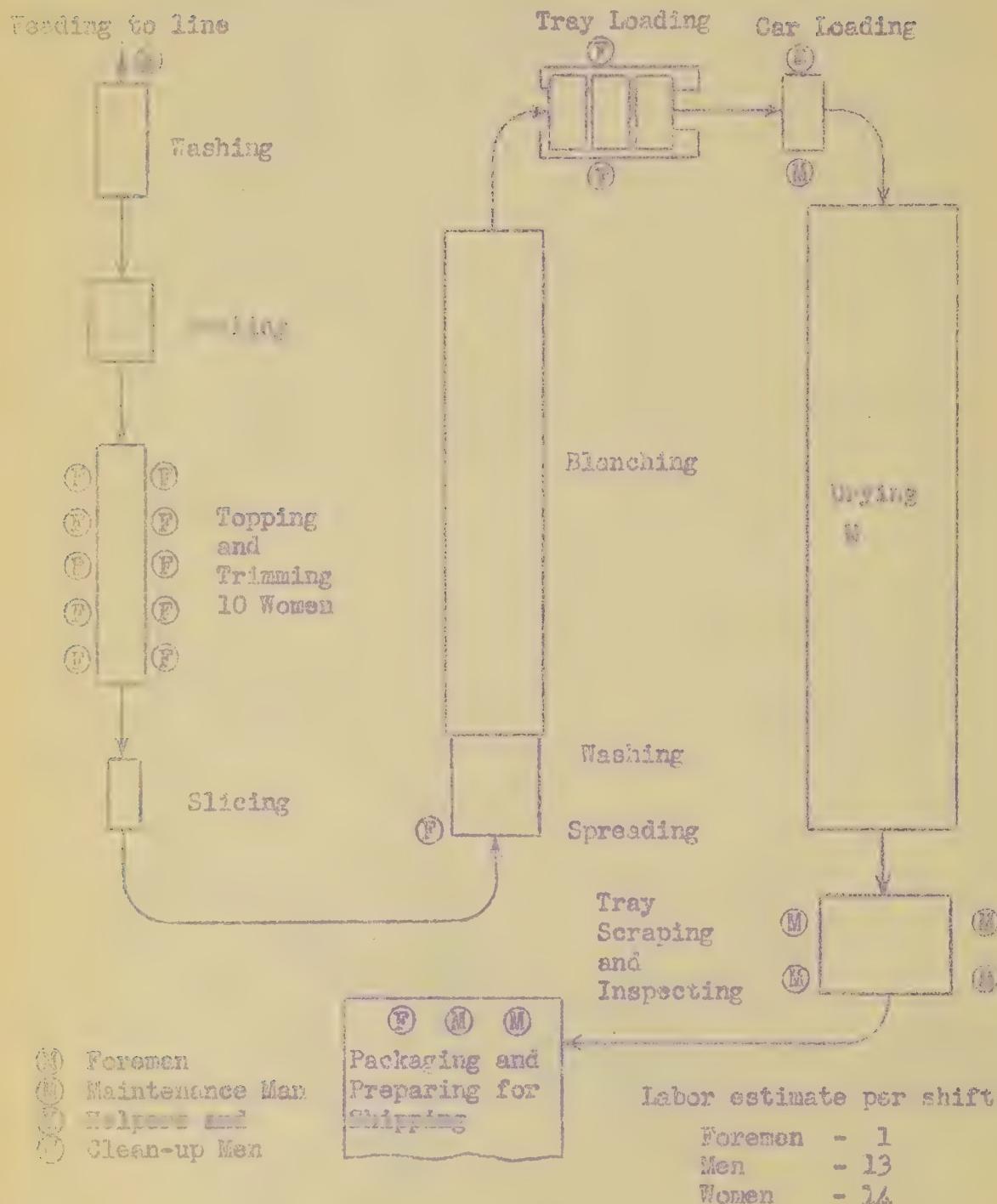


TURNIPS

DEHYDRATION FLOW SHEET

1670 Pounds per Hour

Unprepared Basis



Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department

If further detailed information is
desired, inquiries should be addressed
to:

The Dehydration Committee
Bureau of Agricultural Chemistry
and Engineering
U. S. Department of Agriculture
Washington, D. C.

The Dehydration Committee
Bureau of Agricultural Chemistry
and Engineering
U. S. Department of Agriculture
800 Buchanan Street
Albany, California



Dehydration Committee
Bureau of Agricultural Chemistry and Engineering
U. S. Department of Agriculture

ESTIMATES OF EQUIPMENT COSTS AND LABOR REQUIREMENTS
IN
VEGETABLE DEHYDRATION

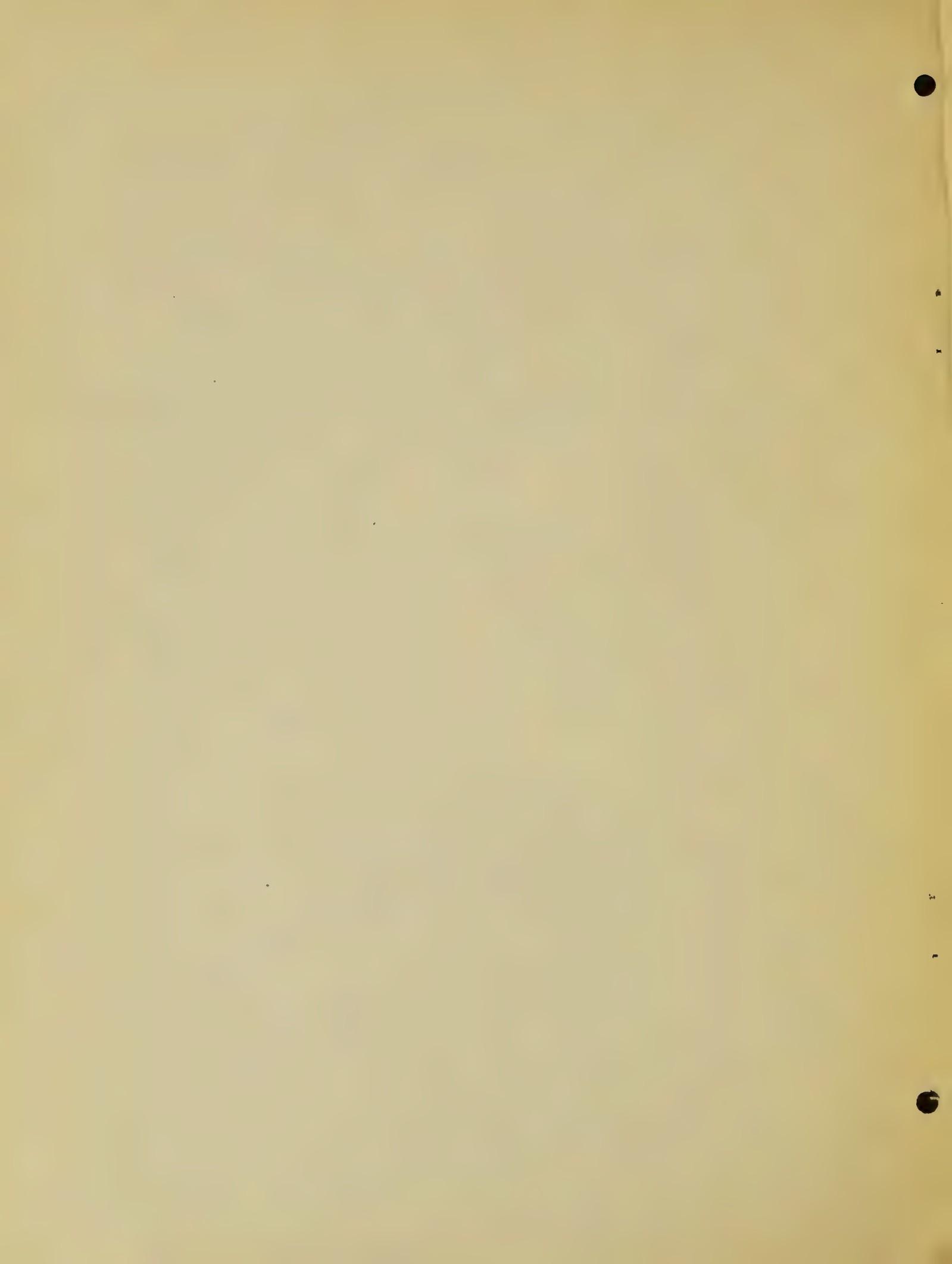
Plant Capacity--3,330 Pounds Per Hour
(Unprepared Basis)



Note:

Preparation, final inspection and packaging equipment are the only types of equipment considered in this report. All labor requirements except clerical and shipping are included.

August 1942



APPENDIX E - COSTS OF PROCESSING

SUMMARY OF EQUIPMENT AND LABOR COSTS
(for seven vegetables important in dehydration)

CAPACITIES PER UNIT OF TIME
(for seven vegetables important in dehydration)

PREPARATION, FINAL INSPECTION, AND PACKAGING EQUIPMENT,
AND LABOR REQUIREMENTS:

| | |
|-----------------------|----------|
| Beets | 100 lbs. |
| Cabbage | 100 lbs. |
| Carrots | 100 lbs. |
| Onions | 100 lbs. |
| Potatoes | 100 lbs. |
| Sweet Potatoes (Yams) | 100 lbs. |
| Turnips (Rutabagas) | 200 lbs. |

FLOW SHEETS:

| | |
|-----------------------|----|
| Beets | 60 |
| Cabbage | 72 |
| Carrots | 62 |
| Onions | 75 |
| Potatoes | 65 |
| Sweet Potatoes (Yams) | 60 |
| Turnips (Rutabagas) | 60 |



Preparation, Final Inspection, and Packaging Equipment,
and Labor Requirements in
Vegetable Dehydration at a Plant Capacity of 3,000 Pounds per Hour,
Unprepared Basis

This discussion deals with the labor requirements and cost of preparation and packaging equipment in dehydration plants capable of handling 3,000 pounds per hour, unprepared basis, or 40 tons per 24-hour day. The vegetables considered are:

| Table Beets | Onions | Sweet Potatoes (Yams) |
|-------------|----------|-----------------------|
| Cabbage | Potatoes | Turnips (Rutabagas) |
| Carrots | | |

Costs of equipment and labor for vegetable drying are subject to wide variation. The ability to improvise certain items may permit substantial savings in plant investment as compared to a plant using standard machinery equipment. Proper plant layout may even eliminate some items. The relationship between labor and machinery is a very important factor. The initial cost of a labor-saving machine may be large, but the labor cost saved may be much larger than capital and operating charges on the machine. Relative availability of labor and machinery may determine the production of labor and machine operation in a plant.

Equipment listed herein and indicated methods of operation are intended to be merely suggestive. Other items of equipment as well as other operating procedures may be equally satisfactory or even better. For instance, mechanical abrasive peelers have been assumed. Live peeling, if permitted by purchase specifications, may be preferable on carrots, potatoes, and other hard root vegetables. Other peeling methods, for example, carbonization by flame or radiant heat, followed by vigorous scrubbing, have also shown promise on an experimental basis. Carrots, turnips, and beets are shown as being peeled before topping. Under certain conditions it may be advisable to do the topping before peeling and the trimming after peeling. Standard abrasive peelers have not proven entirely satisfactory on onions. Operators have adopted various expedients to overcome this difficulty.

Costs and descriptions of equipment are based upon prices and information from established manufacturers in this field. The labor set-ups shown are based upon cannery operations and the operations of present commercial dehydrators. They will vary appreciably from plant to plant. If the items of equipment or sequence and methods of operations are different from those given here, the labor set-up must be modified accordingly.

The accompanying tables show only major items of equipment needed in the

preparation of vegetables for drying and in the final inspection and packaging of the dry product. It is recognized that elevators and conveyors may be major items of cost. They have not been specifically included, except in two special instances, because considerable provisioning will usually be done by the plant operator in the installation of these items of equipment or in the arrangement of other equipment so as to eliminate the necessity for their use. A part of the allowance for installation and accessory equipment is intended for this purpose.

There is a tendency to over-peel smaller size vegetables and under-peel larger ones. Hence it is preferable to put only one size through the peeler at a time. This involves the use of a grader or sizer or the purchase of pre-graded vegetables. A rubber spool grader may cost from \$200 to \$700, whereas a simple slat grader that might be satisfactory may be built at the plant at a cost which is only a fraction of the cost of a commercial grader.

A water spray at the beginning of the blancher belt is quite satisfactory in washing the diced, sliced, or striped vegetables. A separate washer to do the same work may cost several hundred dollars. Such a water spray at the front end of the blancher belt tends to prevent overheating in the preparation room by condensing steam escaping from this end of the blancher.

The amount of steam necessary for blanching will vary from plant to plant depending upon losses from the blancher and cans in the evaporation of steam savings. The range may be from 1 to 3 boiler horsepower for each ton of unpeeled vegetables handled per 24-hour period. Except for beans and sweet potatoes, a requirement of 2-boiler horsepower per ton of product has been assumed. Due to repeat blanching used for beans, a slightly larger amount is considered necessary. Sweet potatoes are usually double-peeled and blanched. Due to this double heating, they require somewhat more steam capacity. The plant operator can lessen the investment in steam boilers by insuring proper plant operation to reduce heat losses and by operating the steam boiler above its rated capacity.

Since the continuous peeler will need periodic cleaning, provision has been made for a batch peeler to carry the load while the other peeler is out of action and to handle odd sizes during normal operation. Other than this peeler, the line-up provides for little or no stand-by equipment. Where there is a possibility that the stopping of any machine will interrupt the continuous flow of the product through the plant, the means of substance operation should be available or there should be storage facilities for the product so that it will not deteriorate while standing.

No provision for waste disposal equipment has been made in these estimated costs. Since disposal of waste is a very important and increasing costly factor, it cannot be overlooked in estimating costs. Each plant may have its own method of waste disposal, but it is probable that in the case of potatoes and sweet potatoes, the most economical will involve removing of wastes from the plant by water. This will necessitate a method of separating suspension sediment from the water by screening, settling, or otherwise. These solids may be hauled away, incinerated, or processes for byproduct values. The liquid effluent may be run into a river, a running stream, or to other places of disposal. Other vegetable wastes may be hauled away, burned, or treated for byproduct recovery, but will usually involve a less serious coverage problem. Each of these methods will be subject to sanitary regulation. Due to the many factors involved, no attempt is being made at this time to show the cost of such equipment. Economical disposal of preparation wastes will usually require some ingenuity on the part of plant operators.

One form of prepared vegetable has been considered. Preparation of vegetables in other forms will necessitate the installation of other types of cutters and will usually entail an increase in costs. The labor set-up may also be affected to some extent by resulting differences in blancher loading, tray loading, and drying time.

In the case of onions, at least a portion of the product will usually be converted to a powder form. It is necessary to conduct this operation in a dry atmosphere and special equipment will have to be installed for this purpose. It is advantageous to conduct all onion processing operations in an air-conditioned room at low humidity.

The cost of packaging equipment is based on the assumed use of 1-gallon cans. Recent practice has been to solder the top after filling the can with inert gas. A regulator valve for the gas, relatively inexpensive soldering equipment, and canseals are the main items needed for this type of packaging. Other types of packaging might involve a larger capital investment. Automatic can sealers have been recently introduced. These use a plastic sealing material under the edge of the lid which eliminates the necessity for soldering. No increased capital investment is ordinarily involved in the use of the automatic can sealer since the machines are leased to the user. Equipment operating costs will be higher, due to the rental paid, but there will be more than offset by lower labor costs.

Inspection belts included are straight single-unit belts. All other divided belts will involve higher equipment costs and training time. Their use may, however, result in reduced labor costs.

It is estimated that installation costs will amount to from 10 to 20% of the purchase price of the machinery. Valves, piping, wiring, trucks, bench, scales, tools and other accessories will also allow some allowance for it required items may amount to a total of 30 to 40%. Together these make a total of about 50% to be added to the purchase price to cover costs of installation and accessory items.

The number of employees needed to operate a plant is by no means clear. Increased use of conveyors, chutes, elevators, and other automatic equipment will decrease the need for employees to handle the material.

In placing the prepared material on the trays for drying, it is necessary to spread it uniformly over the surface of the trays. This allows for proper circulation of the air to all of the material and avoids lumps which may not dry. An automatic device for spreading material on the trays and proper size of tray conveyors will reduce the number of people needed at this point. Automatic spreading on blancher belts will accomplish the same result.

The number of women that are employed on sorting and trimming belts will have a marked effect on the operation of the plant. As the number of women increases, more time will be spent on each potato or other vegetable, thus reducing waste and insuring a better dried product. Careful sorting and trimming will decrease the amount of dried material discarded in the final inspection, decrease the likelihood of product rejection, and probably decrease the number of women needed for the final inspection. There will, however, be an optimum point for the most economical operation of the plant in obtaining an acceptable product.

The raw material cost and labor cost per pound of dry product are directly and mainly determined by preparation losses. A saving of even 5% in preparation losses (e.g., a decrease from 15% to 20% preparation loss) may justify the wages for a number of additional women per shift on the sorting and trimming belt. Improvement in the quality of the final product due to additional care in preparation and decrease in waste disposal cost may also be the deciding factors in determining whether an increase in the number of sorters and trimmers is warranted.

It is assumed that the extra men shown on the accompanying charts will assist in actual processing of the material, in care and operation of the equipment, and in removal of wastes from the plant.

The tables and charts assume continuous operation of the plant in three eight-hour shifts. Since actual working time in an 8-hour shift may be only 7 hours, the indicated hourly capacities are only an average of the quantities handled during the entire 8 hours. Quantities handled in any one hour of actual operation will prove to be slightly higher if the average rate of production is to be maintained. The number of employees indicated as a rule is sufficient to cover this difference.

SUMMARY OF COSTS

Preparation, Final Inspection, and Packaging Equipment,
and Labor Requirements in
Vegetable Dehydration at a Plant Capacity of 3,330 Pounds per Hour

Unprepared Basis

| Type of Vegetable | Shrinkage Ratio | Equipment Cost | | | Labor Cost | | |
|-------------------|--------------------|----------------|-------------------|-------------------|-------------------|-----------|-----|
| | | Total | Per Ton 1/ | | (Unpre- pared) | Per Pound | |
| | | | Wet | Dry | | Wet | Dry |
| | | | (Unpre- pared) | (Unpre- pared) | | | |
| | | | \$ | \$ | \$ | \$ | \$ |
| Potato Slices | 13 to 1 | 11,250. | 261. | 3,456. | 0.97 | 12.6 | |
| Cabbage | 19 to 1 | 10,800. | 270. | 5,130. | 0.78 | 14.9 | |
| Carrots | 10 to 1 | 11,700. | 293. | 2,925. | 0.97 | 9.7 | |
| Onions | 14 to 1 | 8,175. | 212. | 2,966. | 0.81 | 11.2 | |
| Total | | 43,825. | 375. | 2,416. | 1.42 | 9.8 | |
| 1/ Potatoes | 4½ to 1 | 14,850. | 371. | 1,671. | 1.11 | 5.6 | |
| Total | 30 to 1 | 11,700. | 293. | 2,925. | 0.98 | 9.9 | |

1/ Equipment cost per ton handled per 24-hour day.

Capacity per Unit of Line
In a Vegetable Processing Plant
Capable of Handling 3,330 Pounds per Hour

(Unprepared Basis)

| | Beets | Cabbage | Carrots | Onions | Potatoes | Pasta (L.) (Yams) |
|--|-------|---------|---------|--------|----------|----------------------|
|--|-------|---------|---------|--------|----------|----------------------|

| | | | | | | |
|---------------|--------|--------|--------|--------|--------|--------|
| Data Prepared | Slices | Shreds | Slices | Slices | Strips | Slices |
|---------------|--------|--------|--------|--------|--------|--------|

Unprepared basis:

| | | | | | | |
|---------------------------------|--------|--------|--------|--------|--------|--------|
| Pounds per 24-hour day | 40 | 40 | 40 | 40 | 40 | 40 |
| Pounds per 24-hour day | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 |
| Pounds per hour | 3,330 | 3,330 | 3,330 | 3,330 | 3,330 | 3,330 |
| Pounds per minute | 56 | 56 | 56 | 56 | 56 | 56 |
| Number of women coring | | 6 | | | | |
| Pounds per woman per hour | | 555 | | | | |
| Pounds per woman per minute | | 9.3 | | | | |
| Number of retorts | | 1 | | | | |
| Blanching time in minutes | | 10 | | | | |
| Minutes per charge per retort - | | | | | | |
| Loading, blanching & unloading | | 20 | | | | |
| Charges per hour | | 3 | | | | |
| Pounds per charge | | 1,110 | | | | |
| Cars or crates per charge | | 2 | | | | |
| Pounds per car or crate | | 560 | | | | |
| Trays per car | | 5 | | | | |
| Pounds per tray | | 112 | | | | |

Prepared basis:

| | | | | | | |
|--|--------|--------|--------|--------|--------|--------|
| Assumed preparation loss | 30% | 25% | 25% | 15% | 25% | 25% |
| Pounds per 24-hour day | 28 | 30 | 30 | 34 | 30 | 30 |
| Pounds per 24-hour day | 56,000 | 60,000 | 60,000 | 68,000 | 60,000 | 60,000 |
| Pounds per hour | 2,330 | 2,500 | 2,500 | 2,830 | 2,500 | 2,500 |
| Pounds per minute | 39 | 42 | 42 | 47 | 42 | 42 |
| Number of women sorting, lapping & trimming | 18 | | 20 | 16 | 40 | |
| Pounds per woman per hour | 130 | | 125 | 175 | 65 | |
| Pounds per woman per minute | 2.2 | | 2.1 | 3.0 | 1.0 | |

Assumed blancher loading -

| | | | | |
|---------------------------------------|-----|-----|--|-----|
| Pounds per square foot | 1.5 | 2.0 | | 2.0 |
| Assumed blanching time in minutes | 3 | 4 | | 4 |
| Pounds in blancher at any one time | 125 | 165 | | 165 |
| Square feet of blancher needed | 85 | 85 | | 85 |

Assumed tray loading -

| | | | | | |
|------------------------|-----|-----|-----|-----|-----|
| Pounds per square foot | 1.5 | 1.2 | 1.5 | 1.2 | 1.5 |
| Pounds per car | 590 | 475 | 590 | 475 | 590 |

Capacities per Unit of Time
In a Vegetable Dehydration Plant
Capable of Handling 3,330 Pounds per Hour (cont'd)

(Unprepared Basis)

| Form Prepared | Beets | | Cabbage | | Carrots | | Onions | | Potatoes | | Sweet Potatoes (Yams) | | Turnips | |
|-------------------------------------|---------|---------|---------|---------|---------|---------|---------|--------|----------|--------|-----------------------|--------|---------|--|
| | Slices | Cubed | Slices | Slices | Slices | Strips | Slices | Slices | Slices | Slices | Slices | Slices | Slices | |
| Cars per 24-hour day | 95 | 125 | 100 | 145 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 110 | |
| Cars per hour | 3.9 | 5.3 | 4.2 | 6.0 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.5 | | |
| Minutes per car | 15 | 11 | 14 | 10 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 13 | | |
| Trays per car | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | | |
| Pounds per tray | 27 | 21.6 | 27 | 21.6 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | | |
| Trays per 24-hour day | 2,070 | 2,780 | 2,220 | 3,150 | 2,220 | 2,220 | 2,220 | 2,220 | 2,220 | 2,220 | 2,220 | 2,370 | | |
| Trays per hour | 86 | 120 | 93 | 130 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 99 | | |
| Trays per minute | 1.4 | 1.9 | 1.6 | 2.2 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.7 | | |
| Seconds per tray | 43 | 32 | 38 | 27 | 38 | 38 | 38 | 38 | 38 | 38 | 38 | 35 | | |
| Assumed overall shrinkage ratio | | | | | | | | | | | | | | |
| Minutes per 24-hour day | 13 to 1 | 19 to 1 | 10 to 1 | 14 to 1 | 7 to 1 | 4½ to 1 | 10 to 1 | | | | | | | |
| Pounds per hour | 6,150 | 4,210 | 8,000 | 5,710 | 11,430 | 17,730 | | | | | | | | |
| Pounds per minute | 260 | 275 | 330 | 240 | 480 | 740 | | | | | | | | |
| Formulas per 5-gallon can | 10 | 5 | 14 | 9 | 10 | 13 | | | | | | | 6 | |
| Cans per 24-hour day | 620 | 340 | 570 | 630 | 1,140 | 1,370 | | | | | | | 1,330 | |
| Cans per hour | 26 | 35 | 24 | 26 | 48 | 57 | | | | | | | 55 | |
| Minutes per can | 2.3 | 1.7 | 2.5 | 2.3 | 1.3 | 1.1 | | | | | | | 1.1 | |

2

NAME OF PLANT
 Preparation, Final Inspection and Packaging Equipment, and
 Labor Requirements
 In a Dehydration Plant Capable of Handling 3,330 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|--|--|------------------|
| | <u>Description of Equipment</u> | C st |
| Feeding to Preparation Line | | 2 M |
| Washing | Corrugated drum washer Drum size - 24" x 12' With 1½ h.p. motor | \$1,200. |
| Blanching - 30 minutes at 5 pounds pressure in retorts | Horizontal retort - 2 car capacity Cylinder - 54" x 7½" 30 trays and 6 retort cars | 1,050. 3 250. |
| Peeling | Continuous peeler With 3 h.p. motor Stand-by batch peeler With 1½ h.p. motor | 1,100. 600. |
| Topping and Trimming | Belt conveying sorter Belt size - 30" x 27' With 1½ h.p. motor | 1,050. 13 M |
| Washing | Washer elevator with water boot Draper width - 24" With 1 h.p. motor | 500. |
| Slicing | Cutter and slicer With 2 h.p. motor | 700. |
| Tray loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | 2 M 3 M |
| Moving Cars and Drying | | 2 M |
| Scraping Trays | Scraping done over end of conveyor | 4 F |
| Final Inspecting | Belt conveying sorter Belt size - 30" x 20' With 1½ h.p. motor | 4 F |
| Packaging and Preparing for Shipping | Scales, table and sealing equipment | 150. 2 M |

TABLE MERTS (continued)

| <u>Operation</u> | <u>Equipment</u> |
|--|--|
| | <u>Description of Equipment</u> |
| General - Foreman | |
| Helpers, cleanup, washing trays, and maintenance | |
| Sub-total | |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | 50% |
| Total | |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | |
| Labor Cost per Pound - (13 to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 25 Women @ 60¢ per hour \$15.00 21 Men @ 75¢ " " 15. 1 Foreman |
| | Labor cost per wet pound (3,330 lbs) |
| | Labor cost per dry pound (256 lbs) |
| Steam Generating - Approximate Boiler Horsepower Needed - ($2\frac{1}{2}$ b.h.p. per ton per day) For blancher only. Approximate Cost of Boiler if Operated at Rated Capacity | 100 b.h.p. \$6,000. |

CABBAGE
 Preparation, Final Inspection and Packaging Equipment, and
 Labor Requirements
 In a Dehydration Plant Capable of Handling 3,530 Pounds per Hour

Unprepared Basis

| | <u>Equipment</u> | <u>Cost</u> |
|---|--|-------------|
| | <u>Description of Equipment</u> | |
| Feeding to Preparation Line | Belt conveyor Belt size - 16" x 60' With 3 h.p. motor | |
| Trimming and Coring | Belt conveying sorter Belt size - 30" x 12' With 1 h.p. motor 6 Improvised cabbage corers With 1 h.p. motor Located over belt | |
| Blanching | Corrugated drum washer Drum size - 24" x 12' With 1½ h.p. motor | |
| Shredding | Knout cutter 32½" disc With 2 h.p. motor | 2,100. |
| Spreading on Blancher Belt | | |
| Blanching, 3 Minutes - Loading on blancher belt, 1½ pounds per square foot. | Wire belt blancher Overall length - 34' Covered area - 42" x 25' With 2 h.p. motor | 2,000. |
| Tray Loading and Stacking | Rollers, scales, end other loading equipment are small items. These are included in cost of accessory equipment. See below. | 2 3 |
| Drying, Curing and Drying | | |
| Scraping Trays | Scraping cone over end of conveyor. | |
| Final Inspection | Belt conveying sorter Belt size - 30" x 20' With 1½ h.p. motor | |

DAMAGE (continued)

| <u>Operation</u> | <u>Description of Equipment</u> | <u>Cost</u> | <u>Labor</u> |
|---|--|-------------------------|--------------|
| Packaging and Preparing for shipping | Scales, table, and sealing equipment | \$ 150. | 2 2 |
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | | 1 1 |
| | | | 5 5 |
| | Sub-total | \$7,200 | |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | | 50% | 3,600 |
| | Total | \$10,800 | |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | \$ 270 | |
| Labor Cost per Pound - (19 to 1 overall shrinkage ratio) Based on the labor cost per hour) | 16 Women @ 60¢ per hour 20 Men @ 75¢ " " 1 Foreman | \$9.60 15.00 1.50 | \$ 26.10 |
| | Labor cost per wet pound (3,330 lbs) | | |
| | Labor cost per dry pound (175 lbs) | | |
| Steam Generating - Approximate Boiler Horsepower Needed (2 b.h.p. per ton per day) For blanching only. Approximate Cost of Boiler if Operated at Rated Capacity | | 80 b.h.p. | |
| | | \$5,100 | |

CARROTS

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements

In a Dehydration Plant Capable of Handling 3,330 Pounds per Hour

Unprepared Basis

| | Description of Equipment | Cost |
|---|--|----------|
| Feeding to Preparation Line | | |
| Washing | Corrugated drum washer Drum size - 24" x 12' With 1½ h.p. motor | \$1,200 |
| Peeling | Continuous peeler With 3 h.p. motor Stand-by batch peeler With 1½ h.p. motor | \$1,100. |
| Wipping and Trimming | Belt conveying sorter Belt size - 30" x 30' With 2 h.p. motor | \$1,100 |
| | Cutter and slicer With 2 h.p. motor | \$100 |
| Spreading on Blancher Belt | | |
| Washing | Sprays on front end of blancher Included in blancher cost. | |
| Blanching, 7/ Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 34' Covered area - 42" x 25' With 2 h.p. motor | \$2,000 |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below | |
| Moving Cars and Drying | | |
| Scraping Trays | Scraping done over end of conveyor. | |
| Final Inspecting | Belt conveying sorter Belt size - 30" x 20' With 1½ h.p. motor | \$90. |

| <u>Operation</u> | <u>Description of Equipment</u> | <u>Cost</u> | <u>Labor</u> |
|--|---|---|-----------------|
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | \$ 150. | 1 P. 2 |
| General - Foreman Helpers, cleanup try washing and maintenance. | | | 2 A. 5 M. |
| | Sub-total | \$7,800. | |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | | 50% | <u>\$3,900.</u> |
| | Total | \$11,700. | |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | | <u>\$ 293.</u> |
| Labor Cost per Pound - (10 to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 29 Women @ 60¢ per hour 18 Men @ 75¢ " " Labor cost per wet pound (3,330 lbs) Labor cost per dry pound (333 lbs) | \$17.40 13.50 1.50 \$ 32.40 0.4978 9.7 | |
| Steam Generating - Approximate Boiler Horsepower Needed (2 b.h.p. per ton per day) For blanching only. | | 80 b. h. p. | |
| Approximate Cost of Boiler if Operated at Rated Capacity | | | <u>\$5,100.</u> |

OPTIONS

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements

1. A Preparation Line Capable of Handling 3,330 Pounds per Hour

Improved Basis

Handling in Preparation Line

Peeling

Continuous peeler
With 3 h.p. motor
Stand-by batch peeler
With 1½ h.p. motor

Scaling and Trimming

Belt conveying sorter
Belt size - 30" x 24"
With 1½ h.p. motor

Washing

Corrugated drum washer
Drum size - 24" x 12"
With 1½ h.p. motor

Slicing

Cutter and slicer
With 2 h.p. motor

Tray Loading and Stacking

Rollers, scales, and other loading equipment are small items.
These are included in cost of accessory equipment. See below

Moving Cars and Drying

Scraping Trays

Scraping done over end of conveyor

Final Inspecting

Belt conveying sorter
Belt size - 30" x 20"
With 1½ h.p. motor

Packaging and Preparing for Shipping

Scales, table and sealing equipment

General - Foreman

Helpers, cleanup, wash trays, and maintenance

Sub-total

for installation and
accessory equipment; 50% for
same plus improvised items.

50%

Total

Equipment Cost per Ton Handled per
24-Hour Day (Unprepared Basis)

Labor Cost per Pound -
(14 to 1 overall shrinkage)
(Based on the labor cost per
hour)

| | |
|---|-------------|
| 23 Women @ 60¢ per hour | \$13.80 |
| 17 Men @ 75¢ " " | 12.75 |
| 1 Foreman | <u>1.50</u> |
| Labor cost per wet pound (3,330 lbs) | |
| Labor cost per dry pound (238 lbs) | |

POTATOES

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements
In a Dehydration Plant Capable of Handling 3,330 Pounds per Hour

Unprepared Basis

| Operation | Description of Equipment | Cost |
|--|--|----------------|
| Feeding to Preparation Line | | 2 F |
| Washing | Corrugated drum washer Drum size - 24" x 12' With 1½ h.p. motor | \$ 1,200. |
| Sizing | Rubber spool grader Rolls - 20" wide With $\frac{1}{4}$ h.p. motor | 1 M |
| Peeling | Continuous peeler With 3 h.p. motor Stand-by batch peeler With 1½ h.p. motor | 1,100. 600. |
| Sorting and Trimming | Belt conveying sorter) 2 Belt size - 30" x 30")needed With 2 h.p. motor | 2,300. |
| Stripping | Strip cutter and slicer With 2 h.p. motor | 700. |
| Spreading on Blancher Belt | | 2 F |
| Washing | Sprays on front end of blancher - Included in blancher cost. | |
| blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 34' Covered area - 42" x 25" With 2 h.p. motor | 2,000. |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment See below. | 3 M |
| Moving Cars and Drying | | 2 M |
| Scraping Trays | Scraping done over end of conveyor | 4 M |
| Final Inspecting | Belt conveying sorter Belt size - 30" x 20' With 1½ h.p. motor | 1 M |

POTATOES (continued)

| <u>Operation</u> | <u>Equipment</u> |
|---|--------------------------------------|
| | <u>Description of Equipment</u> |
| Packaging and Preparing for shipping | Scales, table, and sealing equipment |
| General - Foreman | |
| Helpers, cleanup, washing trays, and maintenance | |
| Sub-total | |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | 50% |
| Total | |

Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis)

| | |
|--|--|
| Labor Cost per Pound - (7 to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 50 Women @ 60¢ per hour \$30.00 20 Men @ 75¢ " " 15.0. 1 Foreman |
| | Labor cost per wet pound (3,330 lbs) |
| | Labor cost per dry pound (475 lbs) |

| | |
|---|---------|
| Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blancher only. | |
| Approximate Cost of Boiler if Operated at Fated Capacity | 80 b.h. |

2-1-1-tat 156-1

SWEET POTATOES

Inspection, Final Inspection and Packaging Equipment, and

Labor Requirements

100% Polymerization Plant Capable of Handling 3,300 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|--|--|--------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| Feeding to Preparation Line | | 2 M |
| Washing | Corrugated drum washer Drum size - 24" x 12' With 1½ h.p. motor | 4,200. |
| Scalding, 10 Minutes in Boiling Water | Continuous hot water scalding tank - 24" x 14' With 1½ h.p. motor | 1,200. |
| | Continuous peeler With 3 h.p. motor Stand-by batch peeler With 1½ h.p. motor | 1,100. |
| Sorting and Trimming | Belt conveying sorter Belt size - 30" x 36' With 2 h.p. motor | 1,500. |
| Boiling | Cutter and slicer With 2 h.p. motor | 700. |
| Blanching, 6 Minutes - Loading on blancher belt | Sprays on front end of blancher - Included in blancher cost. | 2 M |
| Blanching, 6 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 50' Covered area - 42" x 40' With 2 h.p. motor | 2,700. |
| Gray Loading and Stacking | Rollers, scales, and other loading equipment are small items, being included as accessory equipment. | |
| Conveying Cars and Drying | Scraping done over end of conveyor | 4 M |
| | Belt conveying sorter Belt size - 30" x 20' With 1½ h.p. motor | |

SWEET POTATOES (continued)

| <u>Operation</u> | <u>Equipment</u> | <u>Cost</u> |
|--|--|-----------------|
| | <u>Description of Equipment</u> | |
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | \$ 150. |
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | |
| Sub-total | | \$2,000. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | 50% | \$4,200. |
| Total | | <u>\$4,200.</u> |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | <u>\$4,200.</u> |
| Labor Cost per Pound - (4½ to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 34 Women @ 60¢ per hour \$20.40 20 Men @ 75¢ " " 15.00 1 Foreman 1.50 \$ 36.90 | |
| Steam Generating - Approximate Boiler Horsepower Needed - (3 b.h.p. per ton per day) For scalding and blanching only. | Labor cost per wet pound (3,330 lbs) Labor cost per dry pound (740 lbs) | |
| Approximate Cost of Boiler if Operated at Rated Capacity | 120 b.h.p. \$7,000. | |

TURNTIPS

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements

The following figures assume a capacity of 1,000 pounds per hour.

Unprepared Basis

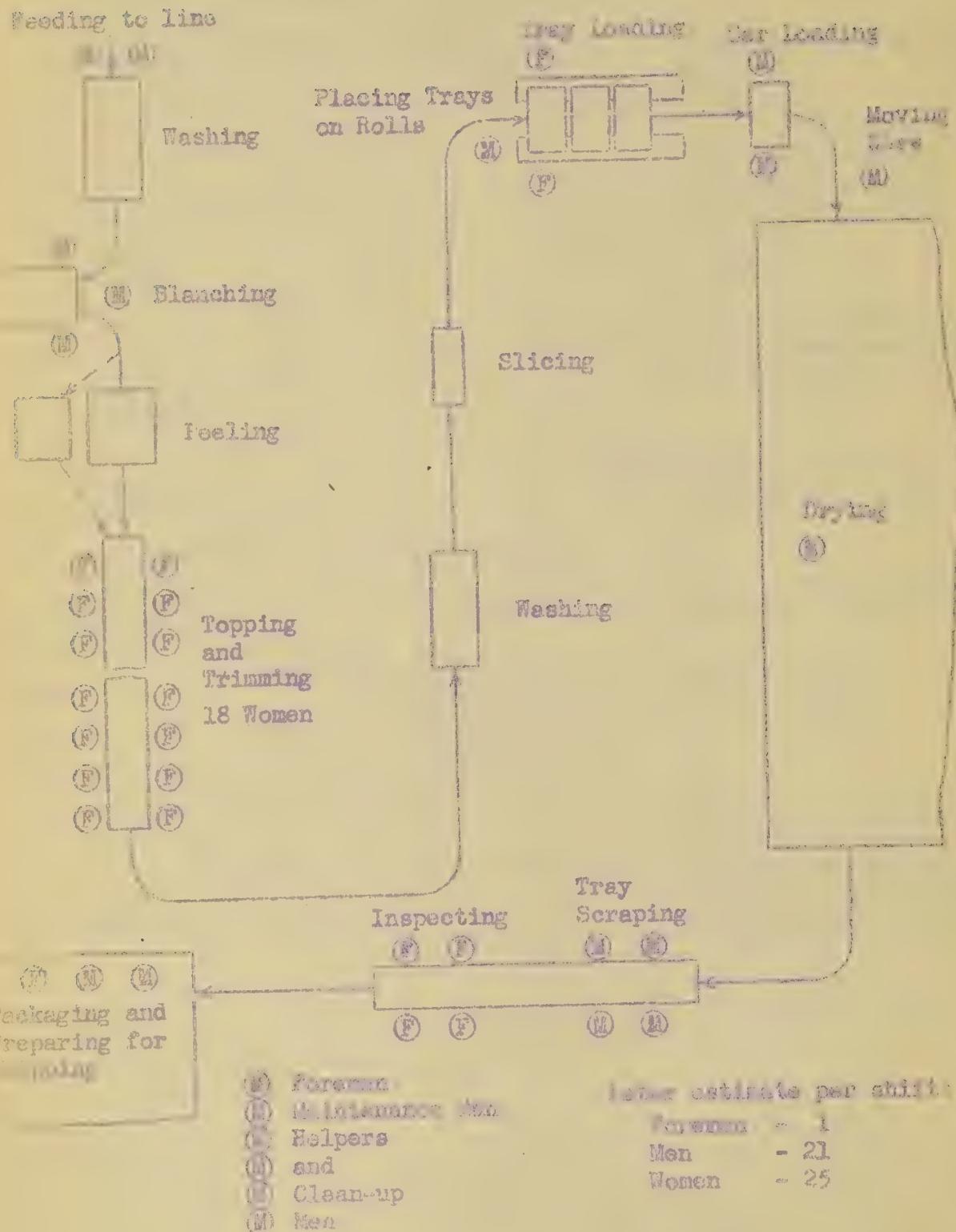
| <u>Operation</u> | <u>Equipment</u> | |
|--|---|----------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| Feeding to Preparation Line | | |
| Washing | Corrugated drum washer Drum size - 24" x 12' With 1½ h.p. motor | \$1,200 |
| Peeling | Continuous peeler With 3 h.p. motor Stand-by batch peeler With 1½ h.p. motor | 1,100. 600. |
| Cutting and Trimming | Belt conveying sorter Belt size - 30" x 27' With 2 h.p. motor | 18 F 1,050. |
| Slicing | Cutter and slicer With 2 h.p. motor | 700. |
| Spreading on Blancher Belt | | 2 F |
| Washing | Sprays on front end of blancher - Included in blancher cost. | |
| Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 37' Covered area - 42" x 28' With 2 h.p. motor | 2,100. |
| Tray loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | 2 F 3 S |
| Moving Cars and Drying | | |
| Scraping Trays | Scraping done over end of conveyor | |
| Final Inspecting | Belt conveying sorter Belt size - 30" x 20' With 1½ h.p. motor | 900. |

TURNIPS (continued)

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|--|--|--|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | \$ 150. |
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | 1 M 5 M |
| Sub-total | | \$7,800. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | | |
| Total | 50% | <u>3,900.</u> <u>\$1,700.</u> |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | \$ 293. |
| Labor Cost per Pound - (10 to 1 overall shrinkage ratio) | 28 Women @ 60¢ per hour 19 Men @ 75¢ " " 1 Foreman | \$16.80 14.25 1.20 <u>\$ 32.55</u> |
| (Based on the labor cost per hour) | Labor cost per wet pound (3,330 lbs) Labor cost per dry pound (333 lbs) | 0.98¢ 9.8 ¢ |
| Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blancher only. Approximate Cost of Boiler if Operated at Rated Capacity | 80 b.h.p. | \$5,100. |

22

SHEETS
DEHYDRATION FLAT SHEET
3330 Pounds per Hour
Unprepared Basis

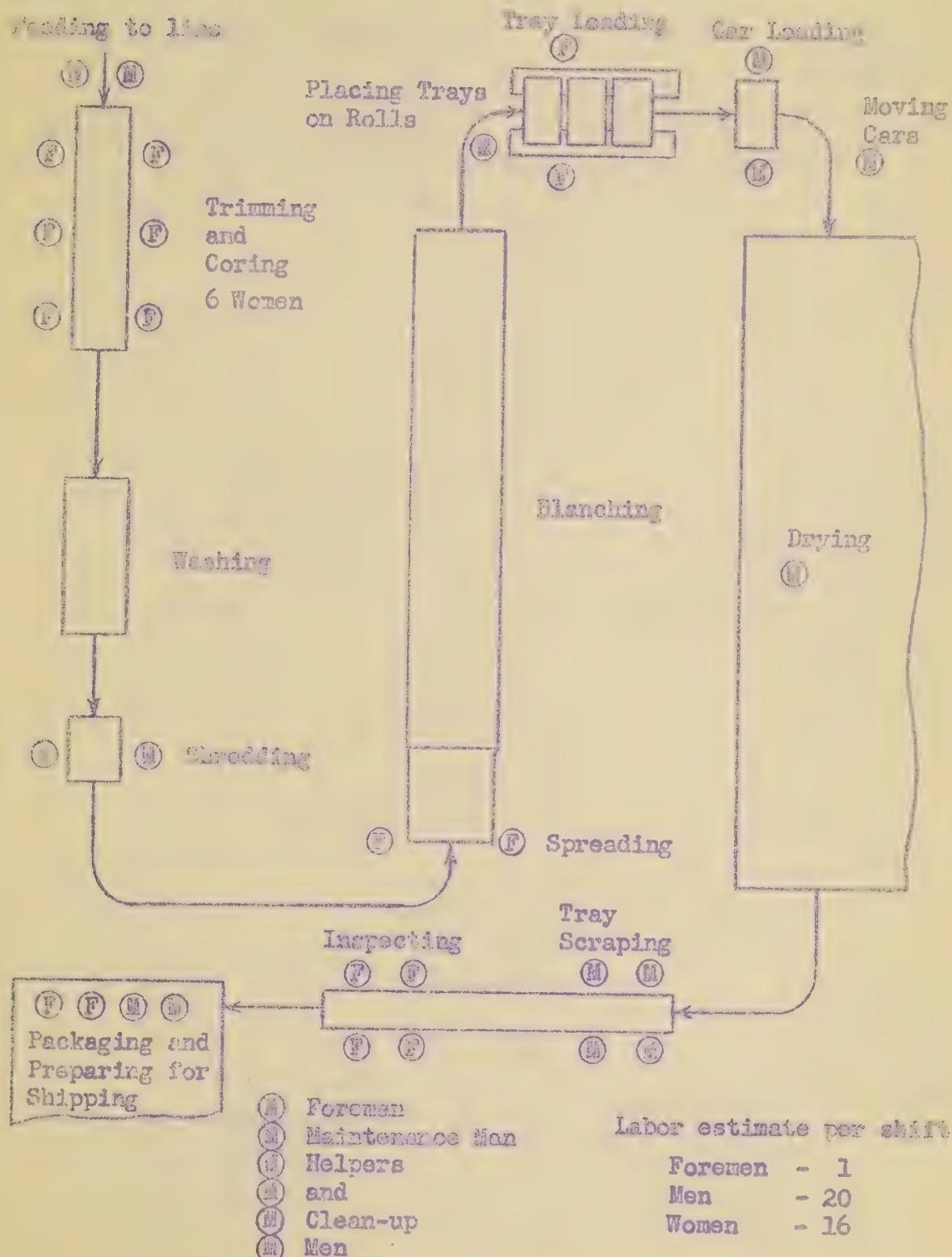


Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Soil Science, U.S. Department of Agriculture,
Washington, D.C., August 1942.

DEHYDRATION FLOW SHEET

3330 Pounds per Hour

Unprepared Basis



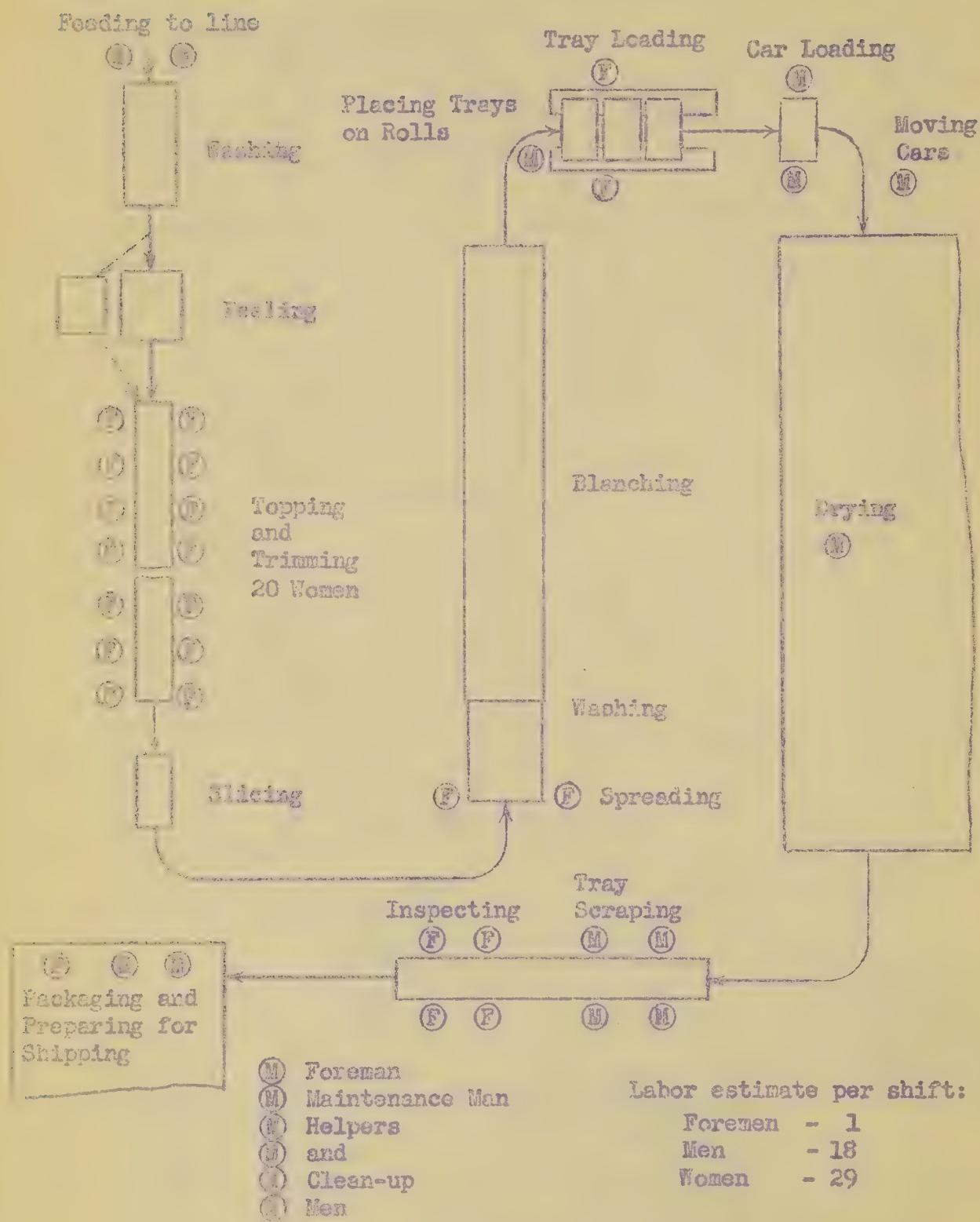
Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

CARROTS

DEHYDRATION FLOW SHEET

3930 Pounds per Hour

Unprepared Basis

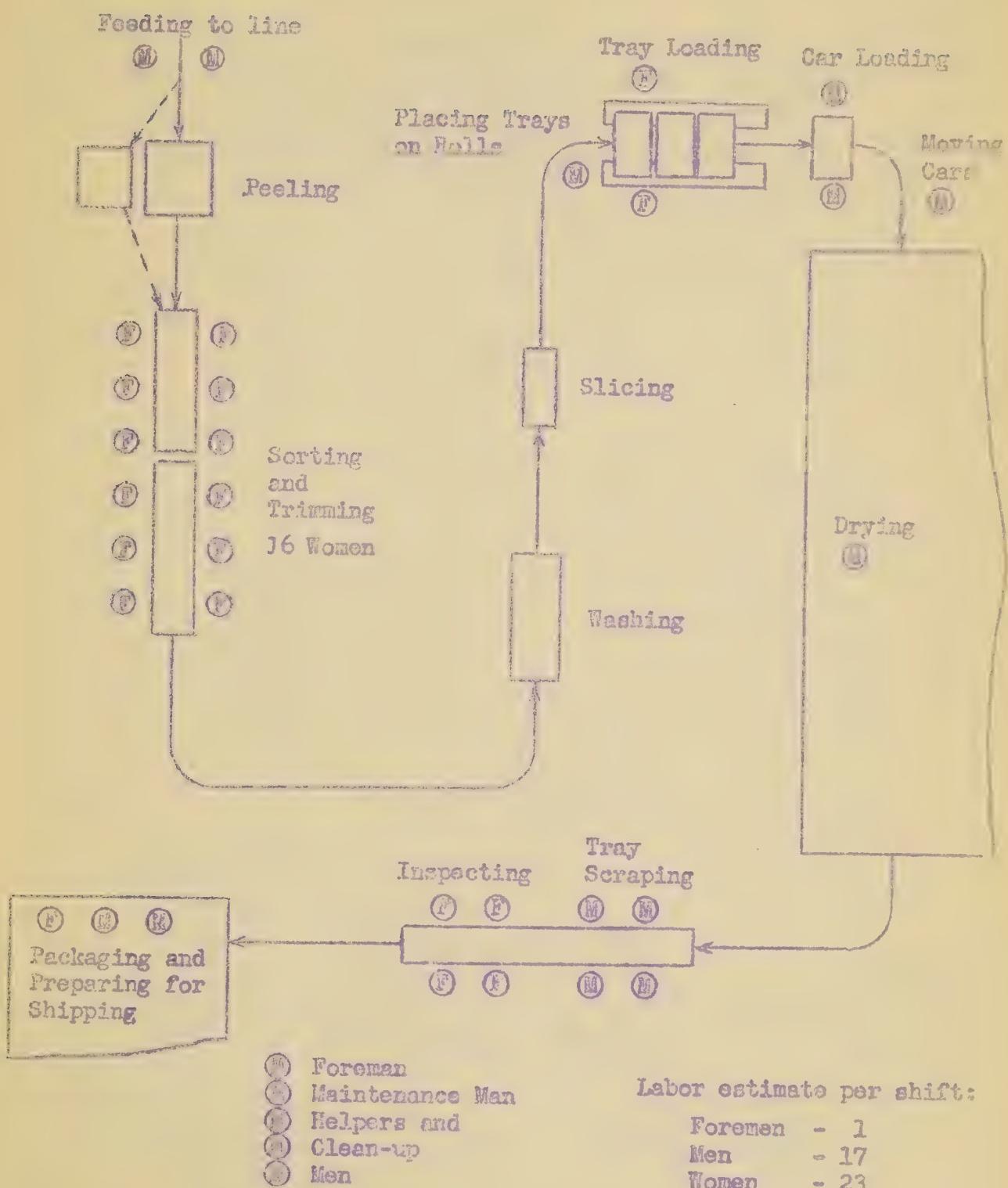


Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

DEHYDRATION PROCESS CHART

3330 Pounds per Hour

Unprepared Basis



Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

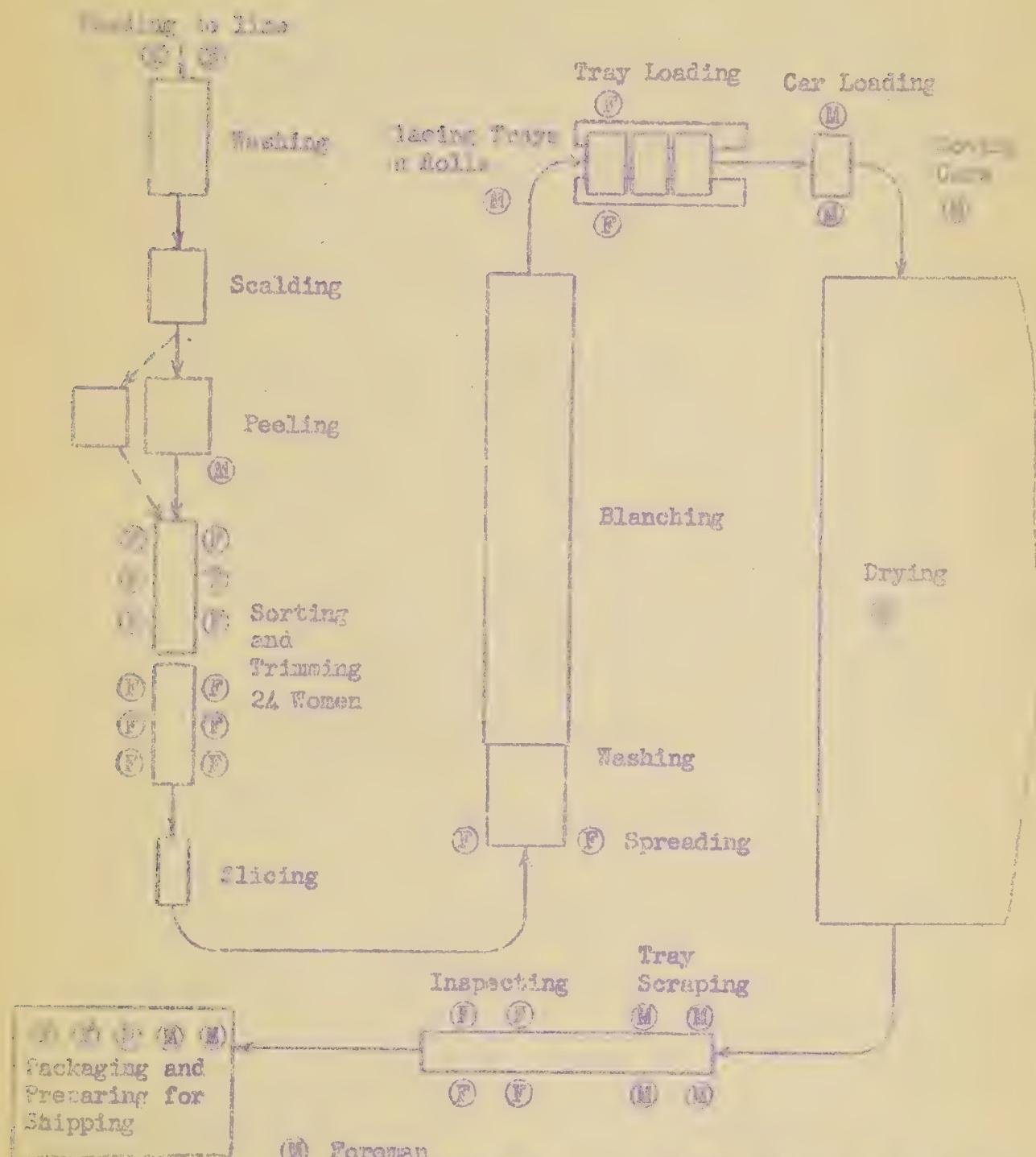
POTATOES
DETERMINATION FLOW SHEET
3330 Pounds per Hour
Unprepared Basis

Labor estimate per shift:

| | | |
|-----------------|---------|------|
| Maintenance Man | Foremen | - 1 |
| Helpers | Men | - 20 |
| and | | |
| Clean-up | Women | - 50 |
| Men | | |

330 Pounds per Hour

Underwater Basins



- (M) Foreman
 - (M) Maintenance Men
 - (M) Helpers
 - (M) and
 - (M) Clean-up
Men

Labor estimates and shifts

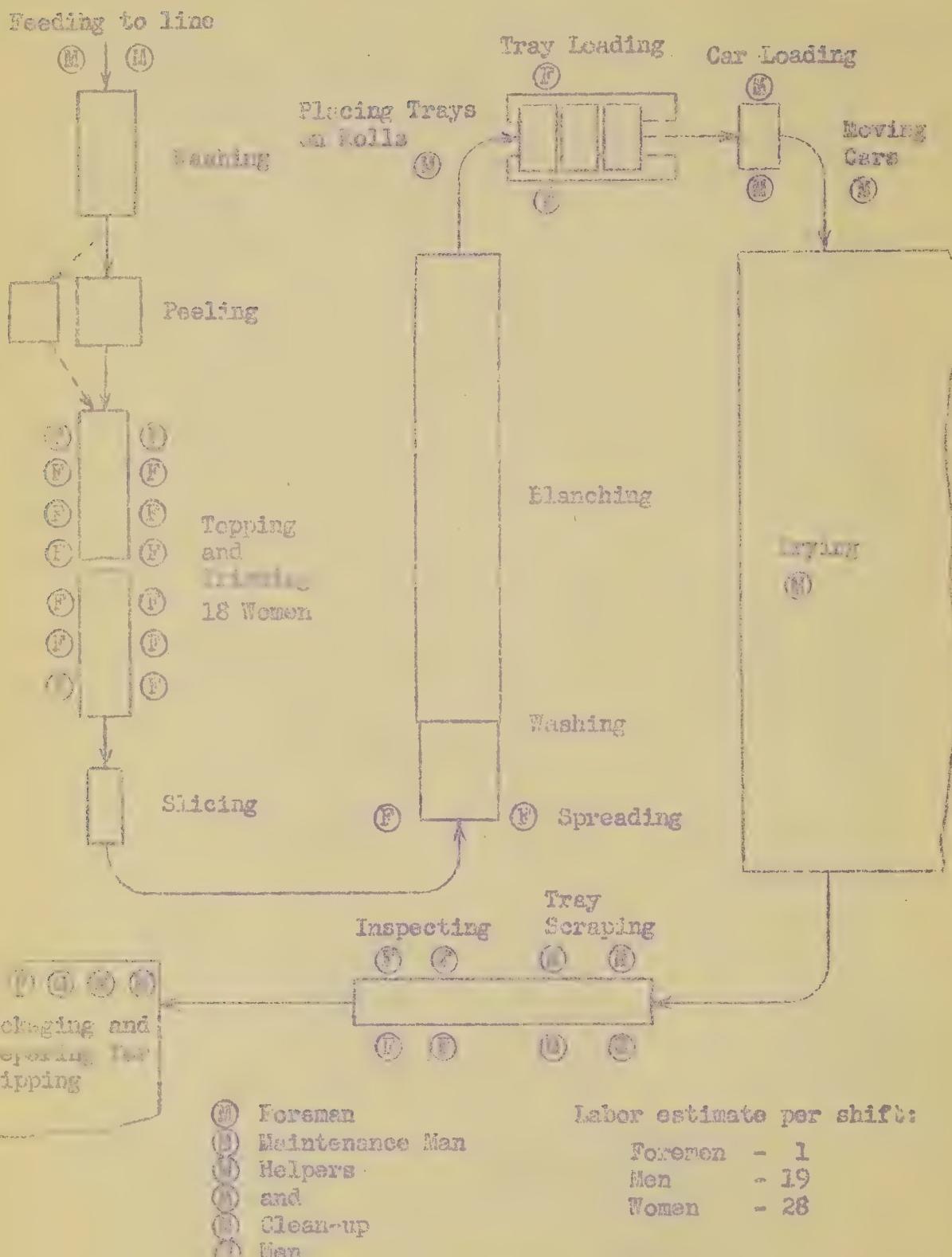
Foremen - 1

Jen - 20

Women - 34

Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

DEHYDRATION
DEHYDRATION FLOW SHEET
3330 Pounds per Hour
Unprepared Basis



Labor estimate per shift:

| | | |
|----------|---|----|
| Forermen | - | 1 |
| Men | - | 19 |
| Women | - | 28 |

Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, January 1919.

If further detailed information is desired, inquiries should be addressed to:

The Dehydration Committee
Bureau of Agricultural Chemistry
and Engineering
U. S. Department of Agriculture
Washington, D. C.

OR

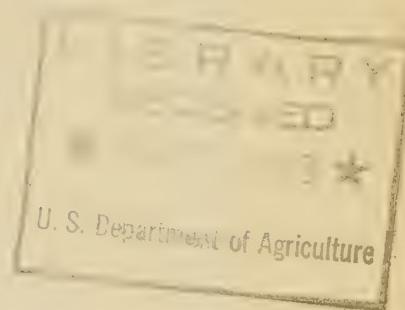
The Dehydration Committee
Bureau of Agricultural Chemistry
and Engineering
U. S. Department of Agriculture
800 Buchanan Street
Albany, California



Dehydration Committee
Bureau of Agricultural Chemistry and Engineering
U. S. Department of Agriculture

ESTIMATES OF EQUIPMENT COSTS AND LABOR REQUIREMENTS
IN
VEGETABLE DEHYDRATION

Plant Capacity--8,330 Pounds Per Hour
(Unprepared Basis)



Note:

Preparation, final inspection and packaging equipment are the only types of equipment considered in this report. All labor requirements except clerical and shipping are included.

August 1942

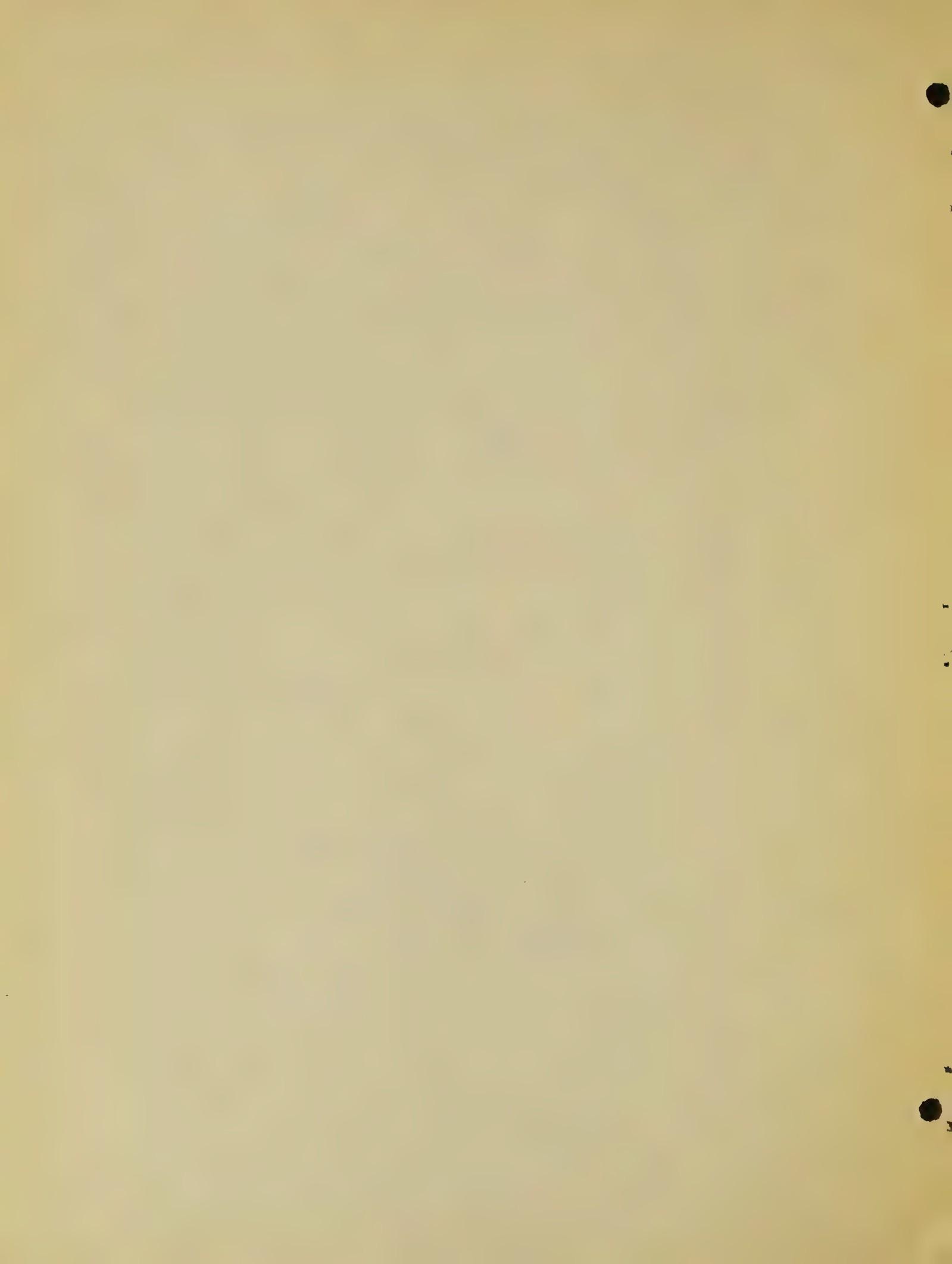
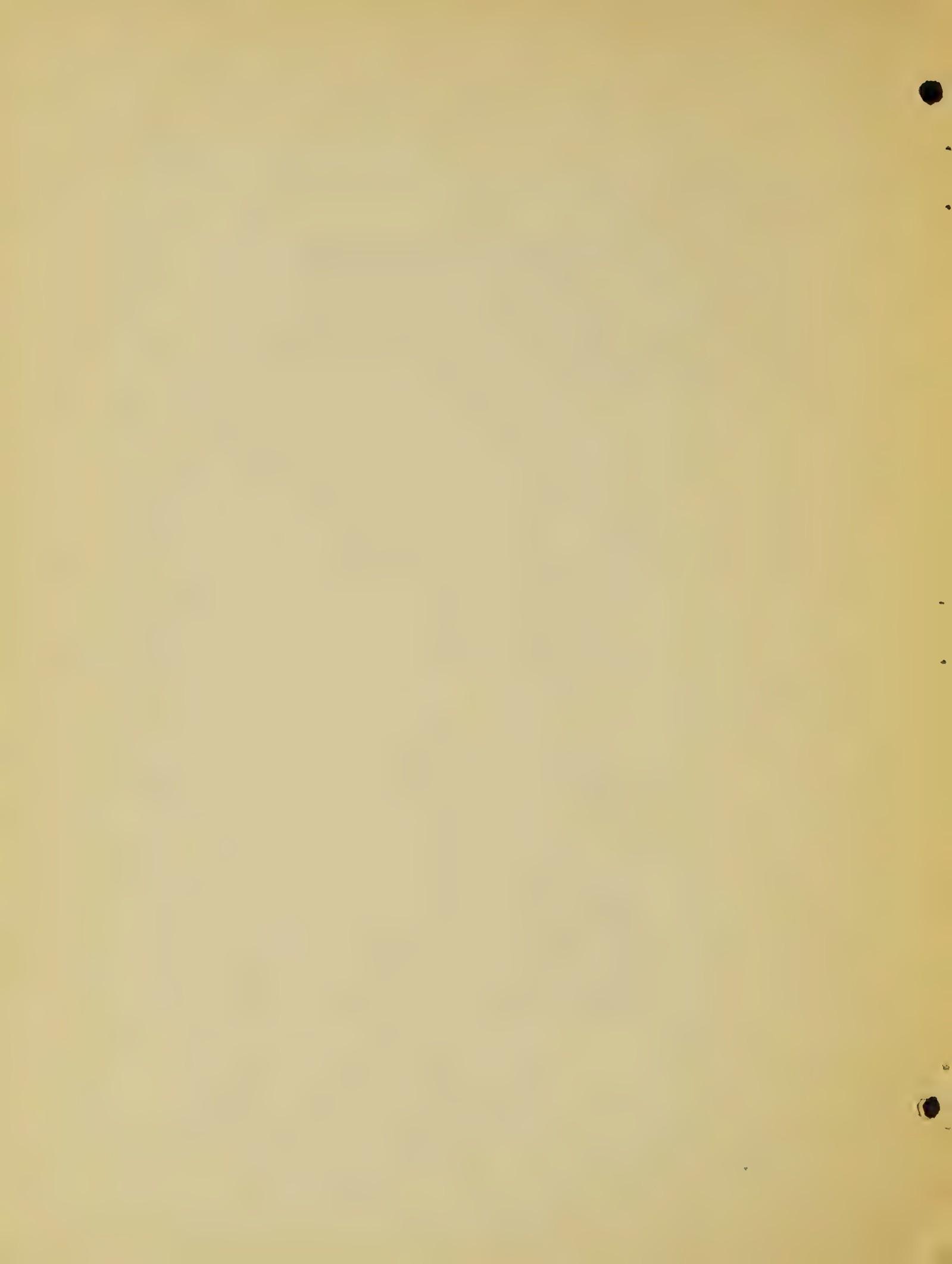


TABLE OF CONTENT

| | |
|--|----|
| GENERAL DISCUSSION..... | |
| SUMMARY OF EQUIPMENT AND LABOR COSTS..... (For seven vegetables important in dehydration) | |
| CAPACITIES PER UNIT OF TIME..... (For seven vegetables important in dehydration) | 17 |
| PREPARATION, FINAL INSPECTION, AND PACKAGING EQUIPMENT, AND LABOR REQUIREMENTS: | |
| Beets | 19 |
| Cabbage | 21 |
| Carrots | 23 |
| Onions | 25 |
| Potatoes | 27 |
| Sweet Potatoes (Yams) | 29 |
| Turnips (Rutabagas) | 31 |
| FLOW SHEETS: | |
| Beets | 33 |
| Cabbage | 34 |
| Carrots | 35 |
| Onions | 36 |
| Potatoes | 37 |
| Sweet Potatoes (Yams) | 38 |
| Turnips (Rutabagas) | 39 |



Preparation, Final Inspection, and Packaging Equipment,
and Labor Requirements in
Vegetable Dehydration at a Flow Capacity of 5,000 Pounds per Hour
Unprepared Basis

This discussion deals with the labor requirements and cost of preparation and packaging equipment in dehydration plants capable of handling 5,000 pounds per hour, unprepared basis, or 100 tons per 24-hour day. The vegetables considered are:

| Table Beets | Carrots | Sweet Potatoes (Yams) |
|-------------|---------|-----------------------|
| Cabbage | Onions | Turnips (Rutabagas) |

Costs of equipment and labor for vegetable drying are subject to wide variation. The ability to improvise certain items may permit substantial savings in plant investment as compared to a plant using standard cannery equipment. Proper plant layout may even eliminate some items. However, due to the large quantities of vegetables passing each point in the operating cycle, it must be recognized that any improvised equipment will have to be extremely rugged.

The balance between labor and machinery is a very important factor. The initial cost of a labor-saving machine may be large, but the labor saved may be much larger than capital and operating charges on the machine. Relative availability of labor and machinery may determine the proportion of labor and machine operation in the plant.

Equipment listed herein and indicated methods of operation are intended to be merely suggestive. Other items of equipment as well as other operating procedures may be equally satisfactory or even better. For instance, mechanical abrasive peelers have been used. For peeling, if permitted by purchase specifications, may be preferable on carrots, onions, and other hard root vegetables. Other peeling methods, for example, carbonization by flame or radiant heat, followed by vigorous scrubbing, have also shown promise on an experimental basis. Carrots, turnips, and beets are shown as being peeled before topping. Under certain conditions it may be advisable to do the topping before peeling and the trimming after peeling. Standard abrasive peelers have not proven entirely satisfactory on onions. Operators have adopted various expedients to overcome this difficulty.

Costs and descriptions of equipment are based upon prices and information from established manufacturers in this field. The labor set-ups shown are based upon cannery operations and the operations of present commercial dehydrators. They will vary appreciably from plant to plant. If the items of equipment or sequence and methods of operations are different from those given here, the labor set-up must be modified accordingly.

The accompanying tables show only major items of equipment needed in the handling of vegetables for drying and in the final inspection and packaging of the dry product. It is recognized that elevators and conveyors may be major items of cost. They have not been specifically included, except in two special instances, because considerable improvement will usually be done by the plant operator in the installation of these items of equipment or in the arrangement of other equipment so as to eliminate the necessity for their use. A part of the allowance for installation and accessory equipment is intended for this purpose.

Some peeler's have the tendency to over-peel smaller size vegetables and under-peel larger ones. Hence it is preferable to put only one or two through the peelers at a time. This involves the use of a grader or cutter or the purchase of pre-graded vegetables. A make-shift arrangement in a plant this size would not be good economy.

A water spray at the beginning of the blancher belt is quite satisfactory for washing the diced, sliced, or stripped vegetables. This will eliminate the necessity of purchasing a separate washer. Such a water spray at the front end of the blancher belt tends to prevent excessive humidity in the processing room by concreting steam escaping from this end of the blancher.

The amount of steam necessary for blanching will vary from plant to plant depending upon losses from the blancher and care in the avoidance of steam leakage. The range may be from 1 to 3 boiler horsepower for each ton of unprepared vegetables handled per 24-hour period. Except for beets and sweet potatoes, a requirement of 2-boiler horsepower per ton may have been assumed. Due to voters blanching used for beets, a slightly larger amount is considered necessary. Sweet potatoes are boiled as well as blanched. Due to this double heating, they require somewhat more steam capacity. The plant operator can lessen the investment in steam boilers by insuring proper plant operation to minimize the steam losses and by operating the steam boiler above its rated capacity.

Since box-cutter peelers will need periodic cleaning, provision has been made for a batch peeler to carry the load while one of the peelers is out of action and also to handle odd sizes during normal operation. Two others or strippers have also been listed. Other than for these two operations, the line-up provides for no stand-by equipment. Where there is a possibility that the stopping of any machine will interrupt the continuous flow of the product through the plant, some means of substitution operation should be available or there should be storage facilities for the product so that it will not deteriorate while standing. Due to the large inventories in raw material in a plant this size, the possibility

such blanchers very common. It may be justified in the case of almost all of the major items of equipment. Two steaming belts are preferable to one, both from an operating stand point and because of the possibility of a breakdown. It may even be desirable to provide two smaller blanchers instead of one large one.

necessarily or if the vegetable were to be prepared in two forms. The blanchers listed are high-grade machines with automatic controls. For the same capacity as the single-blancher plant, the cost of the two-blancher plant will be approximately 25% higher. Operability is the big factor in this. The cost of single-type equipment has no appreciable effect when other items of investment are considered; namely, raw material, labor, and plant investment.

The type of product to be handled must be considered. Processing of vegetables in other forms will necessitate the installation of additional equipment and will usually entail an increase in labor. The labor set-up may also be affected to some extent by resulting differences in blancher loading, tray loading, and drying time.

In the case of onions, at least a portion of the product will usually be converted to a powder form. It is necessary to conduct this conversion in a separate building which will have to be specially designed for this purpose. It is advantageous to conduct all onion operations in an air-conditioned room at low humidity.

For canning or shipping, based on the standard use of a single belt peeler, has been to solder the top of the tin cans at the bottom. A gas burner valve for the gas, relatively inexpensive equipment, and cans are the main items needed for this operation. Other types of sealing equipment involve the use of adhesive. Automatic sealers have been recently developed. These use a plastic sealing material under the edge of the lid which adheres to the sealing bar automatically. An increased capital investment is ordinarily involved in the use of the automatic can sealer since the machines are leased to the user. Equipment operating costs will be higher, due to the rental paid, but these will be more than offset by lower labor costs.

Belts used in the industry include straight single-unit belts. These single-unit belts will involve higher equipment costs on the cutting and trimming line. Their use may, however, result in reduced labor requirements in the larger processing plants.

Information for waste disposal equipment has been made in the last section. Since disposal of waste is a very important and sometimes

factor, it cannot be overlooked in setting up a plant, especially if the waste may amount to 25 tons per day. Each plant may have its own method of waste disposal, but it is probable that in the case of onions and sweet potatoes, the most common method will involve carrying of wastes from the plant by water. This will necessitate a method of separating suspended solids from the water by screening, settling, or otherwise. These solids may be hauled away, incinerated, or processed for byproduct values. The liquid effluent may be run into a river, a running stream, or to other places of disposal. Other solid wastes may be hauled away, burned, or treated for byproduct values. This will usually involve a less serious sewerage problem. These wastes will be subject to sanitary regulation. Due to the factors involved, no attempt is being made at this time to determine cost of such equipment. Properful disposal of prepared wastes will usually require some ingenuity on the part of plant managers.

The total installation costs will amount to from 10 to 20% of purchase price of the machinery. Valves, piping, wiring, trucks, scales, tools, and other accessory equipment plus some allowance for items may amount to an additional 30 to 40%. Together these make a total of about 50% to be added to the purchase price to cover costs of installation and accessory items.

The number of employees needed to operate a plant is by no means fixed. If conveyors, chutes, elevators, and other automatic equipment reduce the need for employees to handle the material.

In spreading the prepared material on trays for drying, it is necessary to spread it uniformly over the surface of the trays. This allows for circulation of air to all of the material and avoids lumps which may form.

An automatic device for spreading the material on trays instead of tray conveyors will reduce the number of employees required. Automatic spreading on the blancher belts will give same results.

The women that are employed on sorting and trimming belts will affect on the operation of the plant. As the number of workers increase more time will be spent on each potato or other vegetable, resulting in a better dried product. Careful trimming will decrease the amount of dried material discarded. Final inspection, decrease the likelihood of product reprocessing. It probably decrease the number of women needed for the final trim. There will, however, be an optimum point for the most efficient operation of the plant in obtaining an acceptable product.

The material cost and labor cost per pound of dry product are directly

is heavily influenced by preparation losses. A saving of even 5% in preparation losses (e.g. a reduction from 25% to 20% preparation) would justify the extra cost for a number of additional men per hour of the cutting and loading unit. Improvement in the quality of the final product due to additional time in preparation and decrease in the disposal cost may also be deciding factors in determining whether an increase in the number of sorters and trimmers is warranted.

It is observed that the extra men shown on the accompanying charts will result in actual processing of the material, in care and operation of the equipment, and in removal of wastes from the plant.

The tables and charts assume continuous operation of the plant in three 8-hour shifts. Since actual working time in an 8-hour shift will be only 7 hours, the indicated hourly capacities are only an average of quantities handled during the entire 8 hours. Quantities handled in any one hour of actual operation will have to be slightly larger if the assumed rate of production is to be maintained. The number of employees indicated should as a rule be sufficient to cover this difference.



SUMMARY OF COSTS

Preparation, Final Inspection, and Packaging Equipment,
and Labor Requirements in
Vegetable Dehydration at a Plant Capacity of 3,330 Kilograms per day

Unprepared Basis

| 1) Vegetable | 2) Shrinkage | Equipment Cost | | | | Labor Cost | |
|--------------|--------------|----------------|----------|---------------|--------|-------------|---------|
| | | 3) Ratio | 4) Total | 5) Per Ton 1/ | | 6) Per Hour | |
| | | | | 7) Wet | 8) Dry | 9) Wet | 10) Dry |
| | | | | \$ | \$ | \$ | \$ |
| 1) Potatoes | 32 to 1 | 19.575 | 196 | 2,512. | 0.76 | | |
| 2) Cabbage | 12 to 1 | 12.375 | 130. | 3,605. | 0.54 | 1.12 | |
| 3) Carrots | 19 to 1 | 22.125 | 221. | 2,242. | 0.77 | 1.77 | |
| 4) Onions | 14 to 1 | 13.275 | 132. | 1,942. | 0.67 | 0.91 | |
| 5) Turnips | 7 to 1 | 23.125 | 254. | 1,720. | 1.17 | 0.22 | |
| 6) Potatoes | 14 to 1 | 27.225 | 272. | 1,225. | 0.89 | 1.6 | |
| 7) Cabbage | 10 to 1 | 22.125 | 221. | 2,312. | 0.77 | 1.77 | |

1/ Equipment cost per ton handled per 24-hour day.

Capacities per Unit of Time
In a Vegetable Dehydration Plant
Capable of Handling 8,330 Pounds per Hour

(Unprepared Basis)

| | Beets | Cabbage | Carrots | Onions | Potatoes | Sweet Potatoes (Yams) | Turnips |
|---|---------|---------|---------|---------|----------|-----------------------|---------|
| Prepared | Slices | Shreds | Slices | Slices | Strips | Slices | Slices |
| <u>Unprepared basis:</u> | | | | | | | |
| Pounds per 24-hour day | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Lbs. per 24-hour day | 200,000 | 200,000 | 200,000 | 200,000 | 200,000 | 200,000 | 200,000 |
| Pounds per hour | 8,330 | 8,330 | 8,330 | 8,330 | 8,330 | 8,330 | 8,330 |
| lbs. per minute | 140 | 140 | 140 | 140 | 140 | 140 | 140 |
| Number of women scoring | | 14 | | | | | |
| Pounds per woman per hour | | 595 | | | | | |
| Pounds per woman per minute | | 10 | | | | | |
| Number of retorts | 2 | | | | | | |
| Blanching time in minutes | 10 | | | | | | |
| Minutes per charge per retort - | | | | | | | |
| Loading, blanching & unloading | 24 | | | | | | |
| Time per hour | 5 | | | | | | |
| per charge | 1,670 | | | | | | |
| in crates per charge | 3 | | | | | | |
| lbs. per car or crate | 560 | | | | | | |
| lbs. per car | 5 | | | | | | |
| lbs. per tray | 112 | | | | | | |
| <u>Prepared basis:</u> | | | | | | | |
| Reduced preparation loss | 30% | 25% | 25% | 15% | 25% | 25% | 20% |
| per 24-hour day | 70 | 75 | 75 | 85 | 75 | 75 | 80 |
| Lbs. per 24-hour day | 140,000 | 150,000 | 150,000 | 170,000 | 150,000 | 150,000 | 160,000 |
| Lbs. per hour | 5,830 | 6,250 | 6,250 | 7,080 | 6,250 | 6,250 | 6,670 |
| lbs. per minute | 97 | 105 | 105 | 120 | 105 | 105 | 110 |
| Number of women sorting, cutting and trimming | 46 | | 50 | 40 | 100 | 60 | 46 |
| per woman per hour | 125 | | 125 | 175 | 65 | 105 | 145 |
| per woman per minute | 2.1 | | 2.1 | 3.0 | 1.0 | 1.7 | 2.4 |
| <u>Blanched blancher loading -</u> | | | | | | | |
| lbs. per square foot | 1.5 | 2.0 | | 2.0 | 2.0 | 2.0 | 2.1 |
| Blanched blanching time in minutes | 3 | 4 | | 4 | 6 | 6 | 4 |
| Wounds in blancher at any one time | 315 | 415 | | 415 | 625 | 625 | 445 |
| Square feet of blancher needed | 210 | 210 | | 210 | 310 | 310 | 220 |
| <u>Raw tray loading -</u> | | | | | | | |
| lbs. per square foot | 1.5 | 1.2 | 1.5 | 1.2 | 1.5 | 1.5 | 1.5 |
| | 590 | 475 | 590 | 475 | 590 | 590 | 590 |

Capacities per Unit of Time
In a Vegetable Dehydration Plant
Capable of Handling 8,330 Pounds per Hour (approx.)

(Unprepared Basis)

| Item Prepared | | | | | | Sweet | Turnips |
|-----------------------------|---------|---------|---------|---------|----------|--------------------|---------|
| | Potato | Cabbage | Carrots | Onions | Potatoes | Potatoes (Yams) | |
| | Slices | Shreds | Slices | Slices | Strips | Slices | Slices |
| Pounds per 24-hour day | 235 | 315 | 255 | 360 | 255 | 255 | 270 |
| days per hour | 10 | 13 | 11 | 15 | 11 | 11 | 12 |
| minutes per day | 6.1 | 4.5 | 5.7 | 4.0 | 5.7 | 5.7 | 5.2 |
| trays per day | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| Pounds per tray | 27 | 21.6 | 27 | 21.6 | 27 | 27 | 27 |
| trays per 24-hour day | 5,190 | 6,940 | 5,560 | 7,870 | 5,560 | 4,560 | 5,280 |
| trays per hour | 215 | 290 | 230 | 330 | 230 | 230 | 245 |
| trays per minute | 3.6 | 4.8 | 3.9 | 5.5 | 3.9 | 3.9 | 4.1 |
| seconds per tray | 17 | 13 | 15 | 11 | 15 | 15 | 15 |
| <hr/> | | | | | | | |
| <u>1. Canned Vegetables</u> | | | | | | | |
| per 11-hour day | 13 to 1 | 19 to 1 | 10 to 1 | 14 to 1 | 7 to 1 | 13 to 1 | 10 to 1 |
| days per hour | 15,380 | 10,530 | 20,000 | 14,290 | 22,970 | 11,360 | 11,360 |
| minutes per day | 640 | 440 | 830 | 600 | 1,090 | 1,090 | 1,090 |
| seconds per day | 11 | 7.3 | 14 | 10 | 20 | 20 | 20 |
| <hr/> | | | | | | | |
| <u>2. Canned Potatoes</u> | | | | | | | |
| per 11-hour day | 16 | 5 | 14 | 9 | 10 | 17 | 17 |
| days per 24-hour day | 1,540 | 2,110 | 1,430 | 1,590 | 2,860 | 1,540 | 1,540 |
| minutes per day | 66 | 88 | 69 | 66 | 120 | 117 | 117 |
| seconds per day | 0.9 | 0.7 | 1.0 | 0.9 | 0.5 | 0.7 | 0.7 |

TABLE BEETS
 Preparation, Final Inspection and Packaging Equipment, and
 Labor Requirements
 In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|--|---|--------------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| Feeding to Preparation Line | | 3 M |
| Washing | Corrugated drum washer Drum size - 36" x 12' With 2 h.p. motor | \$1,400. |
| Blanching - 10 minutes at 5 pounds pressure in retorts | Horizontal retort - 3 car capacity Cylinder - 54" x 10' (2 needed) 60 trays and 12 retort cars | 2,200. 4 M 500. |
| Cutting | Continuous peeler) 2 With 3 h.p. motor) needed Stand-by batch peeler With 1½ h.p. motor | 2,200. 600. |
| Capping and Trimming | Belt conveying sorter) 2 Belt size - 30" x 35') 2 with 2 h.p. motor) needed | 2,500. 46 T |
| Washing | Washer elevator with water boot and sprays Draper width - 30" With 1½ h.p. motor | 900. |
| Cutting | Cutter and slicer) 2 With 2 h.p. motor) needed | 1,400. |
| Accessory Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below | 4 F 4 M |
| Scraping Cars and Drying | | 3 M |
| Scraping Trays | Scraping done over end of conveyor | 7 M |
| Final Inspecting | Belt conveying sorter Belt size - 30" x 30' With 2 h.p. motor | 10 P 1,150. |

Plant and Equipment Costs

| <u>Operation</u> | <u>Equipment</u> | <u>Description of Equipment</u> | |
|--|---|---|------------------|
| Packaging and Preparing for shipping | Scales, table, and sealing equipment | | 200. |
| General - Foreman | | | |
| Helpers, cleanup, washing trays, and maintenance | | | |
| | Sub-total | | \$13,050. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items | | 50% | <u>6,525</u> |
| | Total | | <u>\$19,575.</u> |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | | \$ |
| Labor Cost per Pound - (15 to 1 overall shrinkage ratio) | 62 Women @ 60¢ per hour 33 Men @ 75¢ " " 1 Foreman 1.50 | labor cost per wet pound (8,330 lbs) | |
| | | Labor cost per dry pound (641 lbs) | |
| Steam Generating - Approximate Boiler Horsepower Needed --(2½ b.h.p. per ton per day) For blancher only. | | | 250 b.h.p. |
| Approximate Cost of Boiler if Operated at Rated Capacity | | | \$12,500. |

CABBAGE
 Preparation, Final Inspection and Packaging Equipment, and
 Labor Requirements
 In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> <u>Description of Equipment</u> | <u>Labor</u> <u>Cost</u> |
|-----------------------------|--|-----------------------------|
| Feeding to Preparation Line | Belt conveyor Belt size - 18" x 100' With 5 h.p. motor | 3 H \$2,100. |
| Trimming and Coring | Belt conveying sorter Belt size - 30" x 24' With 1½ h.p. motor 14 Improvised cabbage corers With 2 h.p. motor Located over belt | 1,000. 14 F 400. |
| Washing | Corrugated drum washer Drum size - 36" x 12" With 2 h.p. motor | 1,400. |
| Shredding | Blunt cutter) 2 3½" disc) With 2 h.p. motor) needed 1,200. 2 H | 1,200. |
| Blanching on Blancher Belt | Wire belt blancher Overall length - 52' Covered area - 60" x 42' With 3 h.p. motor | 5,200. |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | 4 P 4 S |
| Drying Cars and drying | | 3 K |
| Wrapping Trays | Scraping done over end of conveyor | |
| Final Inspecting | Belt conveying sorter Belt size - 30" x 30' With 2 h.p. motor | |

COST OF BOILER

ESTIMATING
SECTION OF EQUIPMENT

LABOR AND EQUIPMENT

EQUIPMENT

Welders, cleanup, etc.
and maintenance

Sub-total

\$12,650

Add 40% for installation and accessory equipment; 50% for same plus improvised items.

6,250

Total

\$18,975.Equipment Cost per Ton Handled per
24-Hour Day - (Unprepared Basis)\$ 130.

Labor Cost per Pound -

at 60¢ per hour \$19.80

(19 to 1 overall shrinkage ratio) 1 Foreman 1.50

based on the labor cost per

hour at 60¢ per hour

1 hour cost per C. & G. ton

1 hour cost per C. & G. ton

Steam Generating - Approximate

Boiler Horsepower Needed - (2 b.h.p.

200 ft. head)

Appropriate Cost of Boiler if

Operated at Rated Capacity

200 ft. h.p.

\$1,000.

CARROTS
 Preparation, Final inspection and Packaging Equipment, and
 Labor Requirements
 In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> | <u>Description of Equipment</u> | <u>Cost</u> | <u>Labor</u> |
|--|---|---------------------------------|----------------|--------------|
| Feeding to Preparation Line | | | | 2 1/2 |
| Washing | Corrugated drum washer Drum size - 35" x 12' With 2 h.p. motor | | \$1,400. | |
| Peeling | Continuous peeler) 2 With 3 h.p. motor) needed Stand-by batch peeler With 1½ h.p. motor | | 2,200. 600. | |
| Topping and Trimming | Belt conveying sorter) 2 Belt size - 30" x 40') needed With 2 h.p. motor | | 2,800. | 50 F |
| Slicing | Cutter and slicer) 2 With 2 h.p. motor) needed | | 1,400. | |
| Spreading on Blancher Belt | | | | 2 F |
| Blanching | Sprays on front end of blancher. Included in blancher cost. | | | |
| Blanching, 4 Minutes - Loading on blancher belt, two pounds per carrot | Wire belt blancher Overall length - 52' Covered area - 60" x 42' With 3 h.p. motor | | 5,200. | |
| Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | | | 4 1/2 |
| Cooling Cars and Drying | | | | 2 1/2 |
| Scraping Trays | Scraping done over end of conveyor | | | 7 1/2 |
| Carrot Inspecting | Belt conveying sorter Belt size - 30" x 30' With 2 h.p. motor | | | |

| Operation | Description of Equipment | Cost |
|---|--|--|
| Preparation for day | Scales, table, and sealing equipment | 200. |
| General - Foreman | | |
| Helpers, cleanup, tray washing, and maintenance | | |
| Sub-total | | \$14,975. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | 50% | <u>7,475.</u> |
| Total | | <u>\$22,425.</u> |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | <u>\$ 224.</u> |
| Labor Cost per Pound - (10 to 1 overall shrinkage ratio) | 68 Women @ 60¢ per hour 29 Men @ 75¢ " 1 Foreman | \$40.80 21.75 1.50 \$ 64.05 |
| (Based on the labor cost per hour) | Labor cost per wet pound (8,330 lbs) | |
| | Labor cost per dry pound (833 lbs) | 7 |
| Steam Generating - Approximate Boiler Horsepower Needed (1. b.h.p. per ton per day) + blancher only. | | 200 b.h.p. |
| Approximate Cost of Boiler if operated at Rated Capacity | | \$10,000. |

ONIONS

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements
In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> | <u>Labor</u> |
|---|---|-----------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| Feeding to Preparation Line | | 3 1/2 |
| Peeling | Continuous peeler) 2 With 3 h.p. motor)needed | \$2,200. |
| | Stand-by batch peeler With 1½ h.p. motor | 600. |
| Sorting and Trimming | Belt conveying sorter) Belt size - 30" x 30') 2 With 2 h.p. motor)needed | 2,200. |
| Washing | Corrugated drum washer Drum size - 36" x 12" With 2 h.p. motor | 1,400. |
| Slicing | Cutter and slicer) 2 With 2 h.p. motor)needed | 1,400. |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | 4 |
| Moving Cars and Drying | | 2 1/2 |
| Scraping Trays | Scraping done over end of conveyor | 5 1/2 |
| Final Inspecting | Belt conveying sorter Belt size - 30" x 30' With 2 h.p. motor | 1,150. |
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | 2 1/2 200. 3 |

(continued)

| | <u>Equipment</u> <u>Description of Equipment</u> | <u>Cost</u> |
|---|--|-----------------|
| General Foreman | | |
| Helpers, cleanup, washing trays, and maintenance. | | |
| Sub-total | | \$9,250. |
| 40% for installation and accessory equipment; 50% for same plus improvised items | | 50% . . . 1,625 |
| Total | | \$13,875. |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | \$ 139 |
| Labor Cost per Pound - (14 to 1 overall shrinkage) (Based on the labor cost per hour) | 56 Women @ 60¢ per hour 433.60 28 Men @ 75¢ " " 21.00 1 Foreman 1.00 | 455.60 |
| | Labor cost per wet pound (3,200 lbs) | 0.6 |
| | Labor cost per dry pound (595 lbs) | 9.2 |

POTATOES

Preparation, Final Inspection and Packaging Equipment, and
Labor Requirements
In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> <u>Description of Equipment</u> | <u>Cost</u> | <u>Labor</u> |
|--|--|----------------|--------------|
| Feeding to Preparation Line | | | 2 M |
| Washing | Corrugated drum washer Drum size - 36" x 12' With 2 h.p. motor | \$1,400. | |
| Sizing | Rubber spool grader Rolls - 20" wide With $\frac{1}{2}$ h.p. motor | 400. | 1 M |
| Peeling | Continuous peeler) 2 With 3 h.p. motor)needed Stand-by batch peeler With $1\frac{1}{2}$ h.p. motor | 2,200. 600. | |
| Sorting and Trimming | Belt conveying sorter Belt size - 30" x 75') 2 With 5 h.p. motor)needed | 4,400. | 100 F 1 S |
| Stripping | Strip cutter and slicer) 2 With 2 h.p. motor)needed | 1,400. | |
| Spreading on Blancher Belt | | | 2 |
| Cooking | Sprays on front end of blancher - Included in blancher cost. | | |
| Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 52' Covered area - 60" x 42' With 3 h.p. motor | 5,200. | |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | | 4 4 |
| Cooling Cars and Drying | | | 3 M |
| Scraping Trays | Scraping done over end of conveyor | | |
| Conveying | Belt conveying sorter Belt size - 30" x 75' With 2 h.p. motor | 1,150. | 1 |

| | Description of Equipment | Cost | Labor |
|--|---|---------|------------------|
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | \$ 200. | 3 F 5 E |
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | | 1 F |
| | Sub-total | | \$16,750. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | | 50% | <u>8,475.</u> |
| | Total | | <u>\$25,425.</u> |
| Equipment Cost per Ton Handled per hour - (approximate Basis) | | | <u>2.256.</u> |
| Labor Cost per Pound - (7 to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 1.0 Worker @ 60¢ per hour \$71.40 12 Per " 0.75¢ " " 24.00 1 Foreman 1.0¢ . 1 Party Supervisor 1.00 \$ 97.90 | | |
| | Labor cost per wet pound (1.130 lbs.) | | |
| | Labor cost per dry pound (1.10 lbs.) | | |
| Operating - Approximate Boiler Horsepower Needed -(2 b.h.p. per ton per day) For blancher only Approximate Cost of Boiler if Operated at Rated Capacity. | 200 b.h.p. \$10,000. | | |

SWEET POTATOES

Processing, Plant Inspection and Marketing Equipment, Inc.

Labor Requirements

In a Dehydration Plant Capable of Handling 4,330 Pounds per Hour

Unprepared Basis

| | <u>Equipment</u> | <u>Description of Equipment</u> | <u>Cost</u> |
|--|---|---------------------------------|-------------|
| Feeding to Preparation Line | | | |
| Washing | Corrugated drum washer Drum size - 36" x 12" With 2 h.p. motor | | 4,100 |
| Boiling, 10 Minutes in Water | Continuous hot water scalding Tank - 42" x 20' With 2 h.p. motor | | 1,100 |
| Peeling | Continuous peeler) 2 With 3 h.p. motor)needed Stand-by batch peeler With 1½ h.p. motor | | 600 |
| Cutting and Trimming | Belt conveying sorter) Belt size - 30" x 45") 2 With 3 h.p. motor)needed | 3,000 | |
| Cutting and Trimming | Cutter and slicer) 2 with 2 h.p. motor)needed | 1,400 | |
| Proceeding on Blancher Belt | Sprays on front end of blancher - included in blancher cost. | | |
| Blanching, 6 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 73' Covered area - 60" x 63' With 3 h.p. motor | 6,200 | |
| Loading and Stacking | Rollers, scales, and other loading equipment are small items, being included as accessory equipment. | | |
| | Belt size - 30" x 36' | | |

| <u>Operation</u> | <u>Equipment</u> | <u>Description of Equipment</u> |
|---|--|---------------------------------|
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | |
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | |
| | Sub. Total | |
| 100% for installation and accessory equipment; 50% for same plus improvised items. | 50% | |
| | Total | |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | |
| Labor Cost per Pound - (4 $\frac{1}{2}$ to 1 overall shrinkage ratio) (Based on the labor cost per | | |
| | 79 Men @ 60¢ per hour \$47.40 52 Men @ 75¢ " " 24.00 1 Foreman 1.50 \$ 72.90 | |
| | Labor cost per wet pound (8,330 lbs) | |
| | Labor cost per dry pound (3,250 lbs) | |
| Steam Generating - Approximate Boiler Power Needed - (3 b.h.p. per ton per day) For scalding and blancher only. | 300 b.h.p. | |
| Approximate Cost of Boiler if rated at Rated Capacity | | \$15,000. |

TURNIPS

Preparation, Final Inspection and Packaging Equipment and
Labor Requirements
In a Dehydration Plant Capable of Handling 8,330 Pounds per Hour

Unprepared Basis

| <u>Operation</u> | <u>Equipment</u> | |
|--|--|----------------|
| | <u>Description of Equipment</u> | <u>Cost</u> |
| <u>Initial Preparation Line</u> | | |
| Washing | Corrugated drum washer Drum size - 36" x 12' With 2 h.p. motor | \$1,400. |
| Peeling | Continuous peeler) 2 With 3 h.p. motor)needed Stand-by batch peeler With 1½ h.p. motor | 2,200. 600. |
| Cutting and Trimming | Belt conveying sorter) 2 Belt size - 30" x 35")needed With 2 h.p. motor) | 2,500. |
| Slicing | Cutter and slicer) 2 With 2 h.p. motor)needed | 1,400. |
| Spreading on Blancher Belt | | |
| | Sprays on front end of blancher Included in blancher cost. | |
| Blanching, 4 Minutes - Loading on blancher belt, two pounds per square foot. | Wire belt blancher Overall length - 55' Covered area - 60" x 45' With 3 h.p. motor | 5,300. |
| Tray Loading and Stacking | Rollers, scales, and other loading equipment are small items. These are included in cost of accessory equipment. See below. | |
| Moving Cars and Drying | Scraping done over end of conveyor | |
| | Belt conveying sorter Belt size - 30" x 30' With 2 h.p. motor | 1,150. |

TURNIPS (continued)

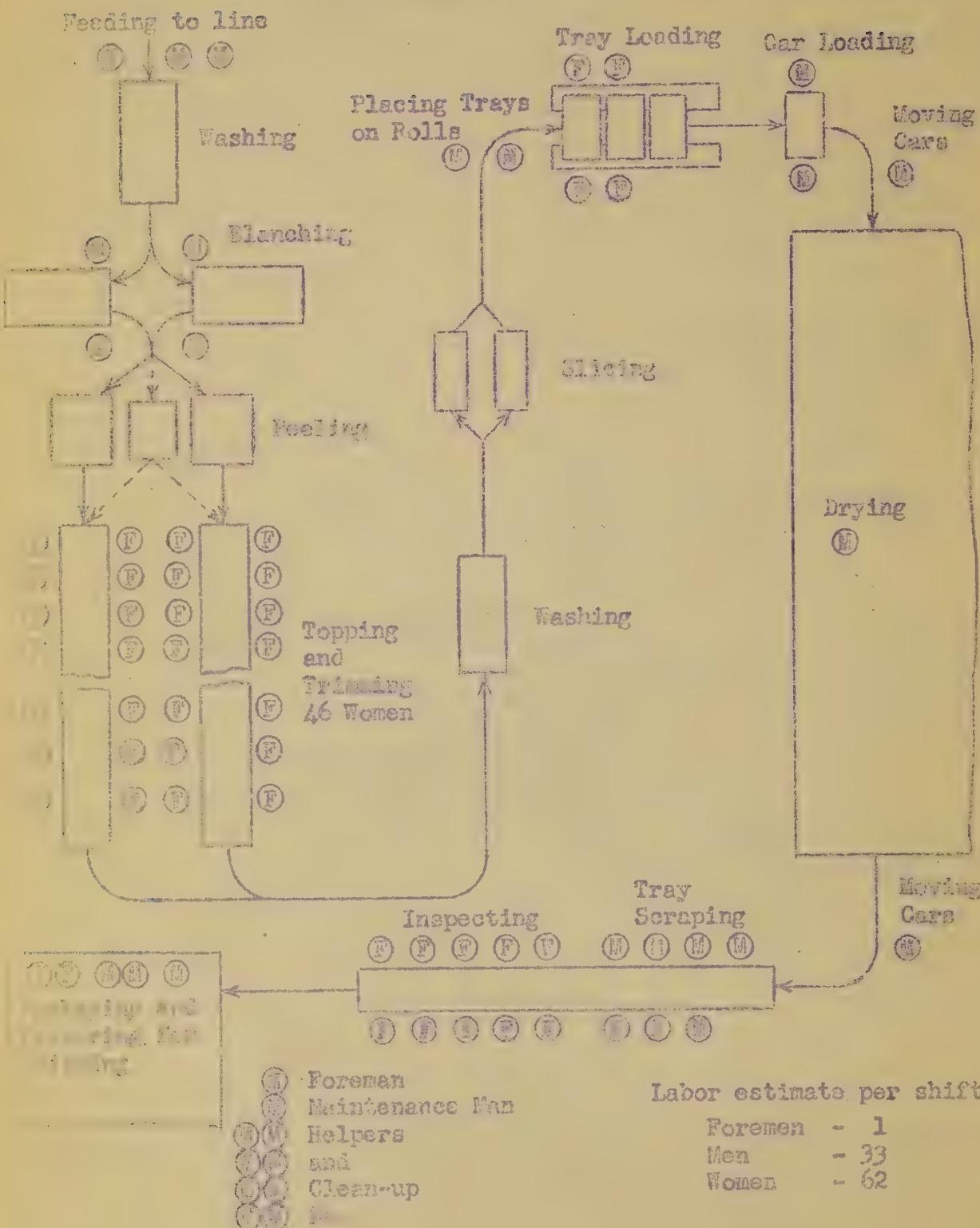
| <u>Operation</u> | <u>Equipment</u> | <u>Description of Equipment</u> | <u>Cost</u> |
|---|--|---------------------------------|------------------|
| Packaging and Preparing for Shipping | Scales, table, and sealing equipment | | \$ 200. |
| General - Foreman Helpers, cleanup, washing trays, and maintenance | | | |
| | Sub-total | | \$14,750. |
| Add 40% for installation and accessory equipment; 50% for same plus improvised items. | 50% | | <u>7,375.</u> |
| | Total | | <u>\$22,125.</u> |
| Equipment Cost per Ton Handled per 24-Hour Day - (Unprepared Basis) | | | \$ 221. |
| Labor Cost per Pound - (10 to 1 overall shrinkage ratio) (Based on the labor cost per hour) | 65 Women @ 60¢ per hour 31 Men @ 75¢ " " 1 Foreman | \$39.00 23.25 1.50 | \$ 63.75 |
| | Labor cost per wet pound (8,330 lbs) | | 0.77 |
| | Labor cost per dry pound (833 lbs) | | 7.77 |
| Steam Generating - Approximate Boiler Horsepower Needed - (2 b.h.p. per ton per day) For blancher only. | | 200 b.h.p. | |
| Approximate Cost of Boiler if Operated at Rated Capacity | | | \$10,000. |

BUITS

DEHYDRATION FLOW SHEET

8330 Pounds per Hour

Unprepared Basis



19. *Leucosia* *leucostoma* *leucostoma* *leucostoma* *leucostoma* *leucostoma* *leucostoma*

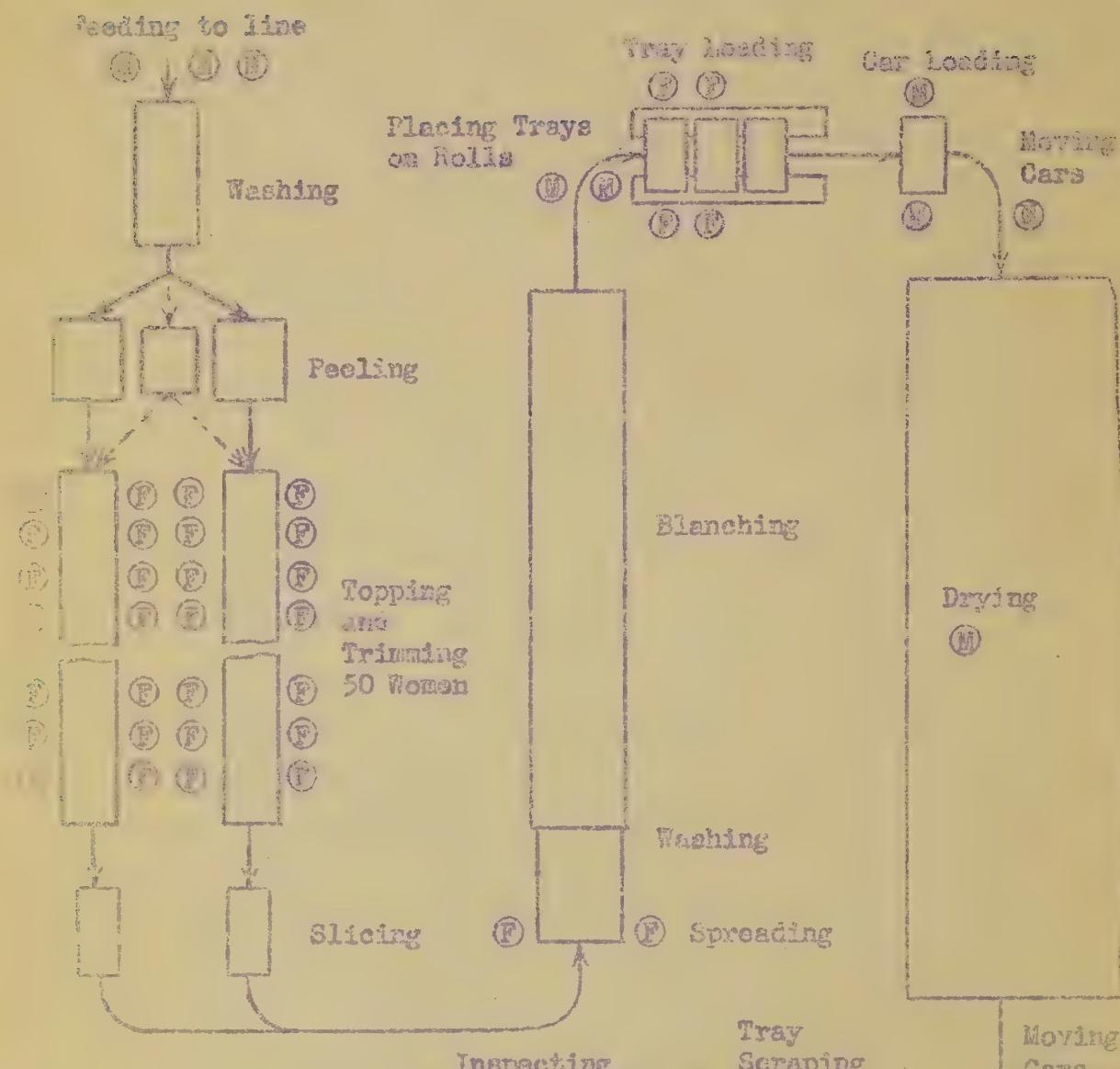
9336: Purple Star Head

Prepared by the Dehydration Com.
Bureau of Agricultural Chemist
Engineering, United States De
of Agriculture, August 1912.

DEHYDRATION FLOW SHEET

8330 Pounds per Hour

Unprepared Basis



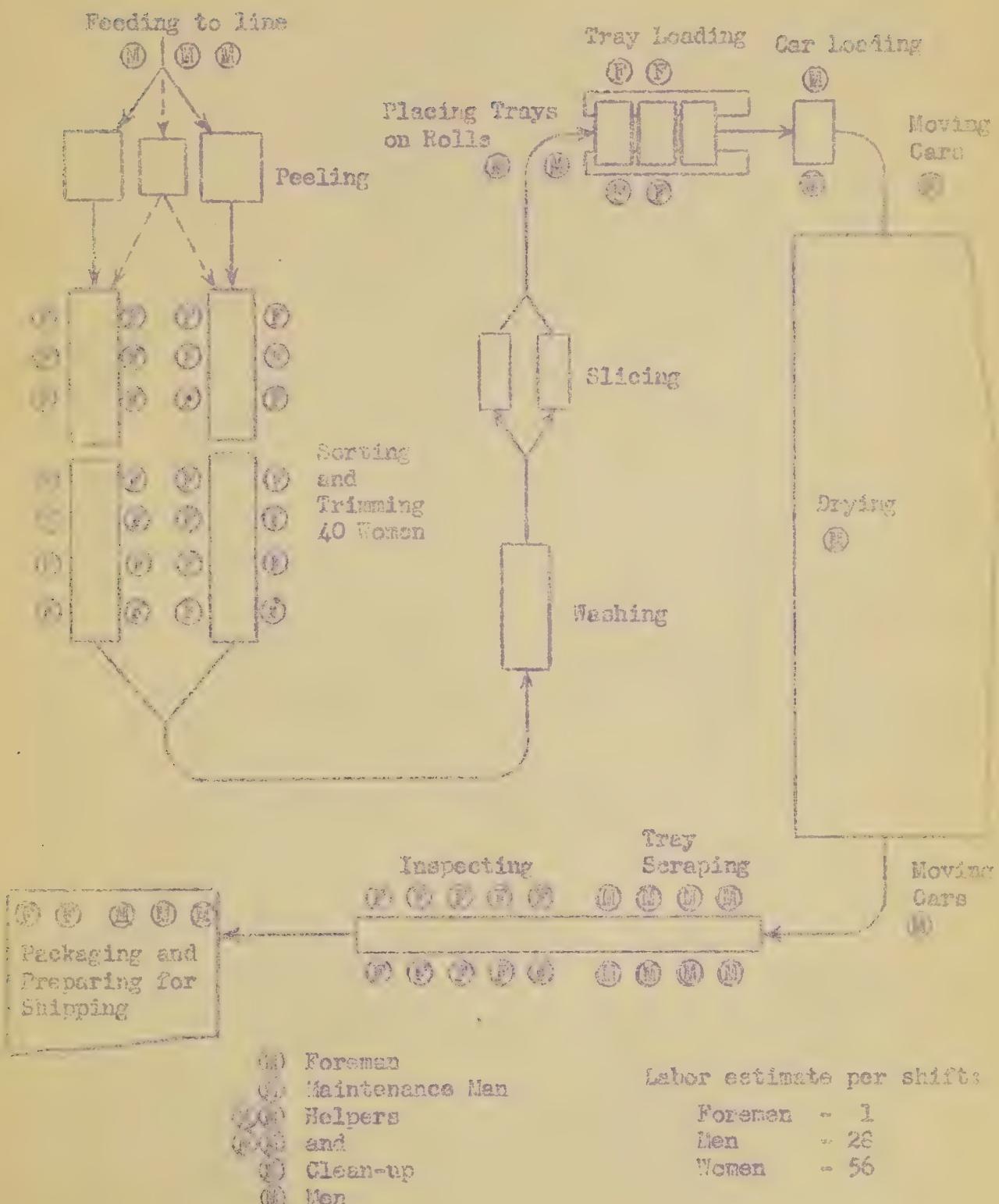
(F) (M) (H) (N)
Packaging and
Preparing for
Shipping

(M) Foreman
(M) Maintenance Man
(H) Helpers
(H) and
(H) Clean-up
(H) Men

Labor estimate per shift:

| | |
|---------|------|
| Foremen | - 1 |
| Men | - 29 |
| Women | - 68 |

IN FLOW OF HP
2330 Pounds per Hour
Unprepared Basis

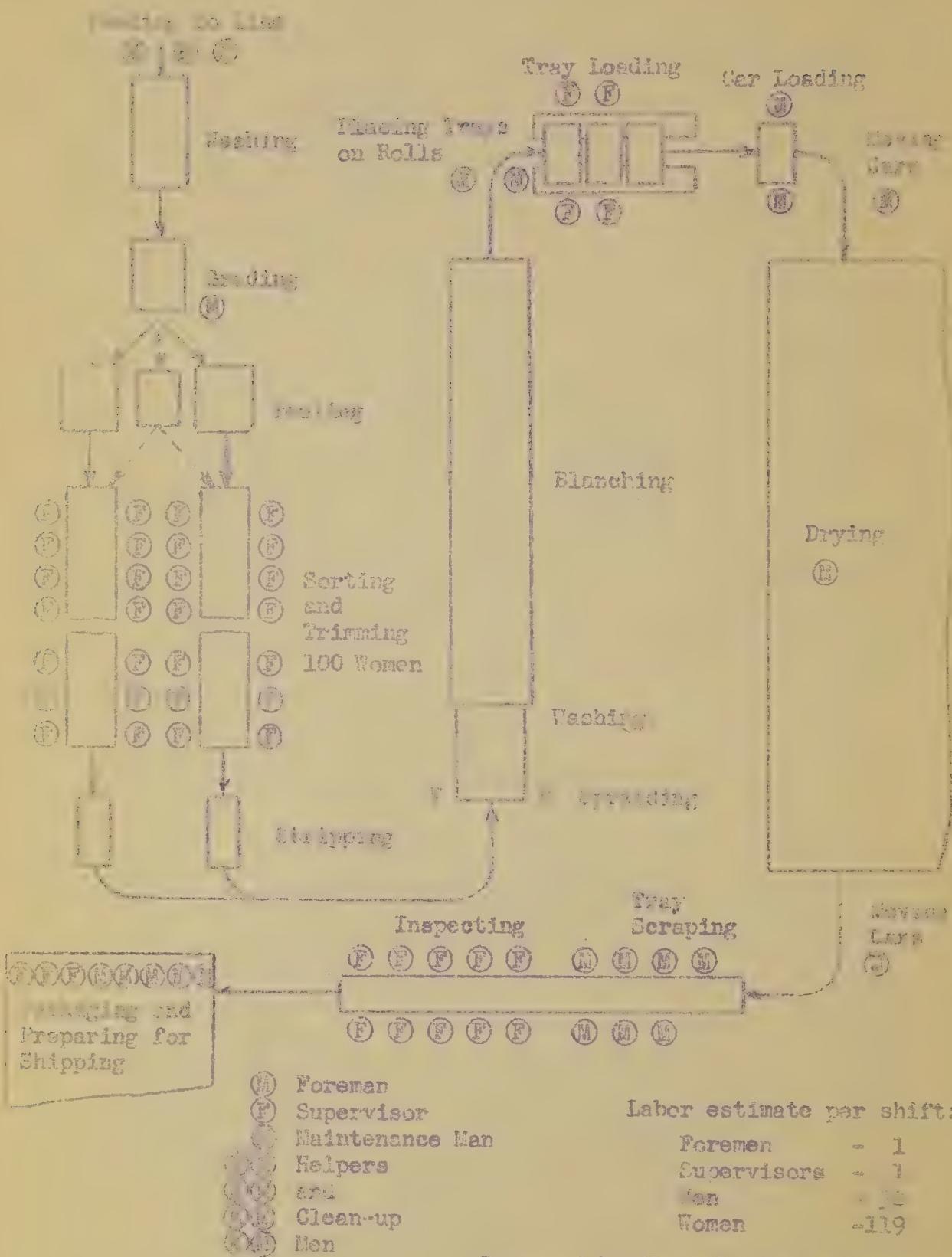


Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

MANUFACTURE PLATE LINES

8300 Pounds per Hour

Unprepared Basis

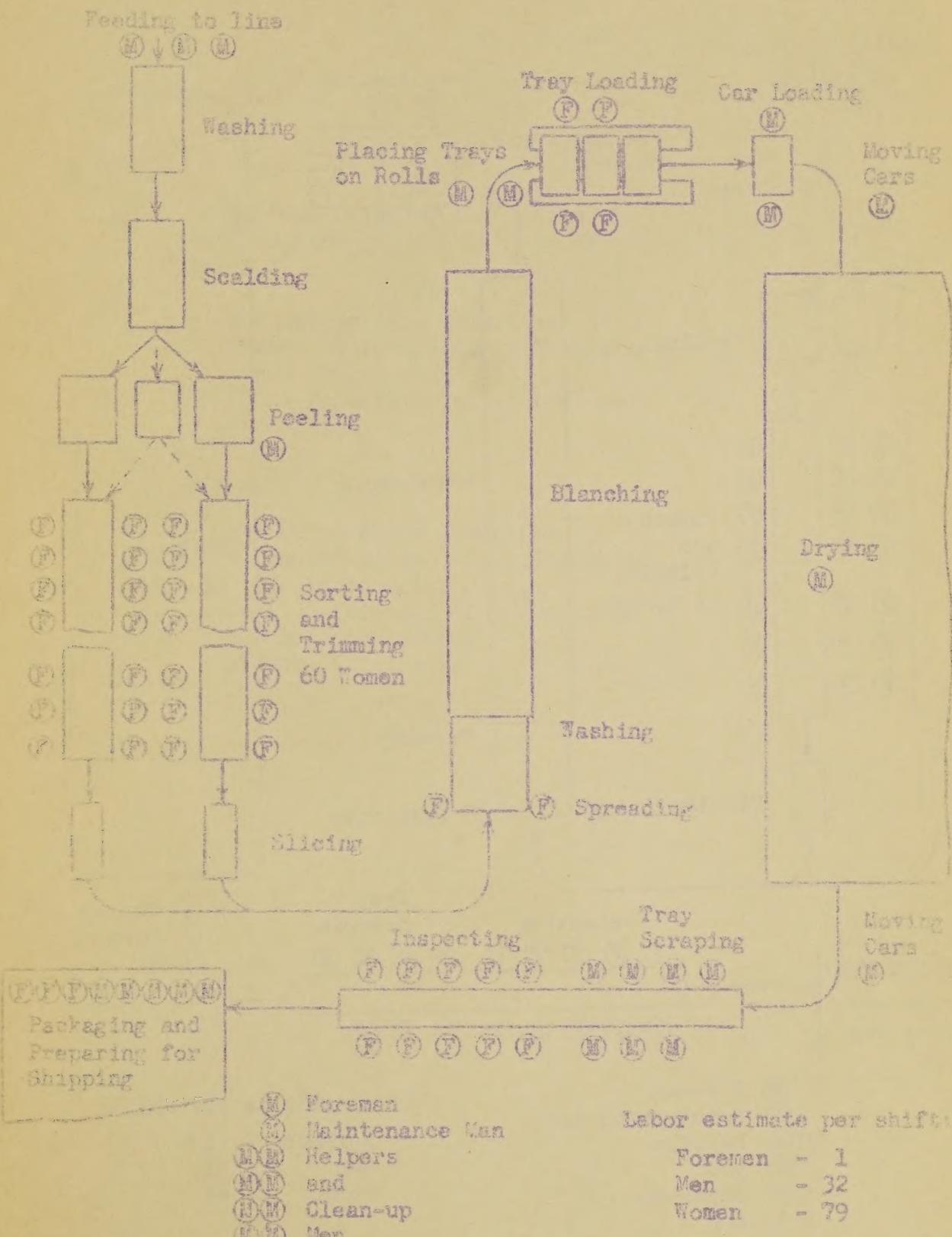


Labor estimate per shift:

| | |
|-------------|-------|
| Foremen | - 1 |
| Supervisors | - 1 |
| Men | - 12 |
| Women | - 119 |

Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

DEHYDRATED POTATOES
DEHYDRATION FLOOR SWIFT
8390 Pounds per Hour
Unprepared Basis



Prepared by the Dehydration Committee
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

Prepared by the Dehydration Committee,
Bureau of Agricultural Chemistry and
Engineering, United States Department
of Agriculture, August 1942.

If further detailed information is
desired, inquiries should be addressed
to:

The Dehydration Committee
Bureau of Agricultural Chemistry
and Engineering
U. S. Department of Agriculture
Washington, D. C.

or to

The Dehydration Committee
Bureau of Agricultural Chemistry
and Engineering
U. S. Department of Agriculture
800 Buchanan Street
Albany, California

